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WHAT TO BELIEVE ABOUT COSMIC RAYS[1]

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IT is almost inevitable that any new field in which there are many workers should appear to the public and even to many of the workers themselves to be in a state of hopeless confusion. This is because the individual workers, unrestrained in a new field by a body of established fact, tend to set up hypotheses that seem to fit their particular experiments or their particular theories and are themselves ignorant of, or at least incredulous about, the findings of others, so that the public soon loses itself in a maze of incompletely understood and apparently contradictory statements and opinions, and knows not whom or what to believe. This situation is not improved by the existence of the daily newspaper, which, as its very name implies, is under a greater pressure to find for its pages something that is new than something that is true. The truth is illusive, as Pilate long ago observed, and it can not possibly be determined in time for the three o'clock edition. If the present craze for the new regardless of the true, in art, science, society and government, goes much further the remedy may be found in the prospect that a nugget of sober uncolored truth may become the most exciting news there is just because of its rarity. I venture the prediction that our present age, because of its craze for the new regardless of the true, will be looked back upon by our children's children with more amazement and ridicule than we ourselves feel because of the credulity of the middle ages or the smugness and hypocrisy of the Victorian age.

In talking therefore, as I am asked to do to-day, to teachers who seek to know what to pass on to their pupils in order to instruct and develop rather than to excite and mislead them, I propose to stick closely

[1] Address on the occasion of a special conference of the Committee on the Place of Science in Education, American Association for the Advancement of Science, Pittsburgh, December 29, 1934.

to the results upon which there is to-day large agreement among the most informed and competent workers and definitely to raise a red flag whenever I come down from the bench and begin to act as an advocate or even as a propounder of unestablished opinions.

But when does an opinion become established? In physics when nine tenths of the competent and informed workers in the field are in agreement upon it. I say nine tenths because I have lived long enough to discover that no matter how simple the problem or how inevitable the conclusion there will always be a small percentage of people who will vote no, and that for no reason whatever except that they are built that way. Here one has left the field of physics and entered the domain of psychology or perhaps pathology. But as I propose to deal with physics to-day rather than with either psychology or pathology I am going to define a practical, working knowledge in physics as that which gets the votes of nine tenths of a competent jury. Parenthetically, you will have noticed that I am quite safe in that definition since I have not specified who is to determine "the competence," and have, therefore, left room for the advocates of "authority and omniscience" still to stay in the party. With that "working formula" to start with, let us get down to articles 1, 2, 3, etc., of the platform.

ARTICLE 1. What are we to believe about the penetrating power of the cosmic rays?

Here we can talk fact, which, up to a certain limit, nobody, so far as I know, will deny. Indeed it was penetrating power alone that led to the discovery of the cosmic rays. Up to 1910 the most general penetrating radiations known, of any sort whatever, were the gamma rays resulting from the radioactive disintegration of uranium and thorium, elements found scattered everywhere in small amounts throughout the earth's crust. The most penetrating of these gamma rays—those from thorium C double prime—were known to be able to pass through a meter and a half of water or 16 cm (about 6 inches) of lead before being reduced to a half per cent., or one two-hundredth part, of their initial strength. These rays were known, too, to have an energy of 2.6 million electron volts. No one prior to 1910 had known of or even seriously suggested the existence of any more penetrating radiations. Such rays given off in the earth's crust were known to be able to make their effect weakly detectable about a kilometer above the earth's surface. The simplest way of detecting them was through measuring their well-known power of discharging electroscopes. When therefore the Swiss physicist Gockel in 1910 took up an electroscope in a balloon to a height of 4 kilometers and found it discharging there even faster than at the surface he had not indeed yet discovered a radiation more penetrating than the gamma rays of thorium, but he had proved definitely that there were other radiations coming in from above in addition to those coming from radioactive substance in the earth's crust. Otherwise stated, he had discovered that the discharging effects observed in his electroscope at a height of 4 kilometers did not arise from these radioactive materials in the earth but from some other cause. But the only other possible causes even of the penetrating rays found at the earth's surface had been discussed at length in preceding years and discarded in favor of radioactive materials in the earth's crust. They were (1) radioactive materials distributed in the upper atmosphere which would presumably have a low penetrating power, like gamma rays, or (2) radiations coming in from outside the atmosphere, which would of necessity contain rays of a high penetrating power, since they would have to get through the earth's atmosphere in order to be felt at the surface. These two causes were both advanced again by Hess the next year, after he had repeated Gockel's experiments, risen to higher altitudes and found the discharging effects continuing to increase with increasing altitude. He favored the second cause, but with correct scientific judgment presented both possibilities, since no measurements on penetrating power had yet been made.

Kolhörster in the next years (1912–14) did commendably precise work of the same kind, rising to 9 kilometers and finding the electroscope discharging effects continuously rising and reaching a value some 6 or 8 times that found at sea level. Nothing further of importance happened until 1922, when Millikan and Bowen first sent electroscopes into the stratosphere (altitude 15.5 kilometers) and obtained electroscope-discharge rates that did not keep rising exponentially in the regions above those reached by Kolhörster as they expected them to do if the rays came in from outside. Up to this time no one had made any direct measurements of penetrating power such as could alone differentiate between these two hypothetical causes and determine unambiguously whether or not rays of a higher order of penetrating power than gamma rays existed.

In the years 1922–25 that question was definitely and finally settled by experiments made in Europe by Kolhörster and in America by Millikan, Otis and Cameron. Kolhörster took electroscope-discharge rates above and beneath shallow bodies of water and also above and in cracks below alpine glaciers and computed from these observations penetrating powers of the order of ten times those of gamma rays, though the effects of local rays from the soil were hard to eliminate and left uncertainties in the minds of some critics. Millikan and Cameron in America analyzed the waters of snow-fed lakes and thus completely elim-

inated the possibility of local effects, and brought to light unambiguously the existence of rays of at least 18 times the penetrating power of gamma rays. In succeeding summers by the same method and with greater accuracy they brought to light rays coming in from above the lake and penetrating with certainty down to a depth of 300 feet or about 100 meters without being reduced to as small a fraction of their surface value as the Thorium C″ rays were found to be at a depth of 1.5 meters; in other words, they found without question rays more than 50 times as penetrating as the gamma rays.

Regener has followed the same kind of measurements in Lake Constance in Switzerland down some two and a half times as far as did Millikan and Cameron in Gem Lake, Calif., with results in substantial agreement with theirs as far as they went down.

The existence, then, of a radiation coming in from above and having a penetrating power varying from six to a hundred times that of gamma rays you may definitely believe in. No one, so far as I know, any longer doubts that much nor has doubted substantially that since 1925.

The existence of rays of any kind of such enormous penetrating power is naturally exciting to the imagination.

But here goes up the red flag! You need not as yet believe claims to much higher penetrating powers. For when one is trying to measure the minute high penetrating tail of the cosmic ray depth-ionization curve caution is the word. Whenever the cosmic ray ionization which it is sought to measure sinks below the zero of the instrument, *i.e.*, below the discharge rate due to internal wall effects and the external radioactive contamination of the surroundings, do not let the sale be consummated until you have got concurring reports from different, independent and dependable appraisers. My own rule for under-water work has been to doubt the dependability of discharge rates less than a thirtieth the discharge rate at the surface. Under especially good conditions this might be stretched to a hundredth, but beyond that do not report to your pupils any conclusions as even probably until two or three independent observers get into agreement upon them. It is just too bad to drag an interested public through all our mistakes as we cosmic ray experimenters have done in numerous instances during the past four years.

So much about what you may believe about the existence of a new and an enormously penetrating radiation.

ARTICLE 2. What may we believe about the place of origin of the cosmic rays?

Here, too, I think I can get my jury into agreement if the word "place" is not too narrowly understood, though it has been a hard job to convince it. From statements widely circulated in the papers, I could not have expected agreement two years ago. Now, however, I think I may say that you may believe that the cosmic rays come from beyond the Milky Way. Some meticulous person may think that a bit roomy to be properly described by the word "place."

Cameron and I convinced ourselves of the correctness of this view in 1925 when we proved by our observations in Muir Lake (altitude 11,800 feet) and Arrowhead Lake (altitude 5,100 feet) that the atmosphere between these two levels acted merely as a blanket and had no effect as a new source of radiation, for we thought that this, combined with the enormous penetrating power of the rays, made it practically certain that they did not originate anywhere in our atmosphere. As I indicated above, both Hess and Kolhörster had favored that view before us, but neither their suggestions nor our arguments seemed to convince the jury, for at the Volta centenary, held at Como, Italy, in 1927, one of the most distinguished and competent of living physicists took the platform after my address and said that although our work had proved indubitably the enormous penetrating power of the cosmic rays and had also shown that these rays did not originate in the lower atmosphere he still preferred to think that they originated in the remoter upper atmosphere. I then advanced the further evidence that we had tested very carefully the independence of the intensity of the rays upon the presence of the sun and felt that it was scarcely thinkable that any events could be taking place in the outer regions of our atmosphere of such a nature as to produce rays of the observed penetrating power that would not also be taking place in the remoter regions of the sun's atmosphere, and if this were true we should detect a very large change in cosmic ray intensity as the earth turned her face toward the sun. To this argument there was no answer and I was later informed by the same authority that he regarded it as quite convincing. But still further evidence has appeared. It consists in the findings made by Clay of Amsterdam as early as 1928 and by a whole group of us since the beginning of 1932 of the influence of the earth's magnetic field on the particle component at sea level of the incoming rays. This shows that these particles must have come in from a distance of at least four or five thousand miles, since the earth's magnetic field, extending as it does out to a distance of ten thousand miles and more, could have no such effect as is observed upon these particles if they originated even in the upper regions of our atmosphere, which extends in appreciable density only for a distance of a few hundred miles at most.

All this evidence taken together has, I think, by this

time convinced the jury that the rays at least do not originate in our upper atmosphere. Even within two years, however, the confusion of thinking that has existed in this field is brought into evidence by newspaper comments and even technical paper comments, to the effect that somebody thinks these rays originate in the stratosphere, said stratosphere having apparently recently become to the public a solvent of all riddles—a kind of cosmic Houdini in the performance of the miraculous.

If, then, the upper atmosphere is excluded as a place of origin, then lack of any significant direct influence of the sun and the Milky Way clearly places the place of origin "beyond the Milky Way." This argument is quite independent of whether the sun may or may not be ultimately shown to exert some minute direct influence. Theoretically it might do this through the effect of secondaries stimulated in its atmosphere by primary cosmic rays that could be assumed to traverse space uniformly in all directions. The only significant consideration for our purpose is that if the sun, or other stars like it, were the original source of the cosmic rays, then on account of its closeness to us it should cause an enormous difference to appear between the daytime and the night-time intensities, which it in fact does not do. The indirect influence of the sun arising from the heating effects in the earth's atmosphere is well known and universally accepted. These, combined with the fluctuations in the rays themselves, have apparently masked any direct influences if they exist. This is a matter on which there is as yet no complete agreement, but it is not important for the action of the jury on the question, Do the cosmic rays come to us from beyond the Milky Way? I think that the jury will answer, "You may believe that they do."

ARTICLE 3. What may we believe about the energies of the cosmic ray particles?

Here again the answer is now very definite so far as it goes. Up to 1931 it was not at all definite. Indeed most of the errors that cosmic ray workers like Millikan, Regener, Jeans and others have themselves made in the years preceding 1931 and passed on in double measure to the public were due to the assumption that one might compute the energies of the cosmic rays from their penetrating powers with the aid of the earlier formulas relating to energy and penetration.

As soon as in the fall of 1931 the workers at the California Institute got into actual use our apparatus for directly measuring these energies the uselessness of these earlier formulae, like that of Klein-Nishina, became at once apparent. For the first thing that we clearly demonstrated was that the most significant factor in the absorption of cosmic rays is the nucleus, while all absorption formulas that had appeared up to that time had ignored it entirely. This result followed from the fact that both positive and negative particles appeared, and in approximately equal numbers, in the Wilson cloud chamber photographs taken by Dr. Anderson, and it had been known for 20 years that positive particles could come only from nuclear encounters.

Do not then believe anything now as to cosmic rays that depends for its credentials upon any theoretical absorption formulae whatever. Some of the newer formulae that try to handle nuclear absorption may be correct, but not one of them has yet established its credentials in the range of cosmic-ray energies.

These Anderson measurements have, however, extended the range of directly measured particle-energies from 15 million electron volts, the highest attained up to 1931, up to 6,000 million electron volts, and you may therefore now believe with entire assurance that charged particles of such energies as these—energies undreamed of five years ago—actually exist. Not only that, but the existence of both a latitude and a longitude effect proves to the satisfaction of the jury that some of these particle-energies reach up to an even higher figure, namely, up to 10 billion electron volts and more. The existence then of charged particle energies of at least 6 billion electron volts and probably of more than 10 billion electron volts is one of the most amazing facts of modern physics.

ARTICLE 4. What are we to believe about the kind of processes that give rise to charged particle bullets of such stupendous energy?

Here goes up the red flag! You may not believe anything as yet about that! The atom-building processes which I earlier thought were adequate to account for the then estimated energies, and which might still be adequate from a purely energetic standpoint to be responsible for the less energetic and more numerous of the cosmic rays, are certainly completely inadequate to account for the highest of these observed energies. There are no processes whatever, that we can have any sort of assurance are taking place, that can be called upon to produce such energies as the highest of those observed. The atom-building processes can not reach higher than to about 2 billion electron volts. Of course there are processes that might be taking place, but remember that everything that anybody says about that subject is purely speculative, legitimately speculative if you will, but do not confuse it with anything that you can now believe!

ARTICLE 5. What may we believe about the nature of the energy-bullets with which the super-bandits of the universe are shooting up our earth and everything

upon it? Are they photon bullets or are they charged-particle bullets?

This last question can be partially answered with definiteness, but only partially. Since photons can only ionize the matter through which they pass by knocking charged particles out of atoms and since the cosmic rays must have come through some matter before entering the earth's atmosphere, the entering cosmic rays must in any case have some of these charged particles as constituents. There has never been any doubt about that in anybody's mind so far as I know.

Further, the existence of an effect of the earth's magnetic field upon the intensity of the cosmic ray—and this is agreed upon by everybody—proves directly that there are these incoming particles. This much, then, you may surely believe. The only question that there has ever been for experiment to determine is whether the incoming rays are all particles or whether they are a mixture of photons and charged particles. Upon this question the jury is still working. It has not yet got into agreement. I expect it to hand in its verdict within a twelvemonth. But for the present believe nothing.

ARTICLE 6. What are we to believe about the effect upon the nucleus of an atom of being hit by cosmic ray shots of the foregoing energy?

Here the results are definite. You may believe that both positive and negative electrons result from that encounter. It was through actually observing in a Wilson cloud chamber such encounters that Anderson made the discovery of the existence of the free positive electron—a discovery that seems to me the most fundamental one that has been made since the discovery of the quantum by Planck in 1900—fundamental because it has forced us to relinquish the beautifully simple concept we had heretofore been content with of a universe built up of but two primordial elements, positive and negative unit charges, the former called the proton because the positive unit charge was thought by its very nature to be about 2,000 times heavier than the negative unit and therefore to carry all save 1/2,000 of the mass of matter. The discovery of the existence of the free positive electron with a mass the same as that of the free negative electron destroys that picture. We need now at least 3 fundamental elements, namely, either (1) positive and negative electrons and neutrons or (2) positive and negative electrons and protons. The discovery, during the preceding year, of the neutron forced no such change in our thinking, for according to its discoverers the neutron was then merely a proton and a negative electron in close association. As many as 15 positive electrons and 7 negative electrons have been actually seen to emerge from a photon encounter with a nucleus of lead. Whether those electrons are all knocked out of the nucleus or are created as positron-negatron pairs by the encounter we do not yet know. But that both free positive and free negative electrons result from the encounter of a cosmic-ray photon with a nucleus there can be no doubt.

ARTICLE 7. What are we to believe about the final fate of these newly found positrons?

They are certainly created, or released, in great numbers by photon encounters of sufficient energy with the nuclei of atoms, probably also, though very much less frequently, by electron encounters with nuclei, and they certainly quickly disappear somehow—since we do not find them in our ordinary studies of either metallic or gaseous conduction. They are thrown out into a world that swarms with extra-nuclear negative electrons, and I think the jury will agree that as soon as their energy is spent they rush together under the influence of the mutual attraction of positive for negative, and the pair thus passes out of existence as electrons, their joint mass, however, being transformed, in accordance with Einstein's equation, into radiant energy in the form of two oppositely directed photons each of an energy value of half a million volts.

These are called annihilation rays and have been many times directly observed. They were first brought to light by Chao at the Norman Bridge Laboratory in 1930 and described by him as isotropically distributed, half million volt rays resulting from the impact of the 2.6 million-volt gamma rays from Thorium C″ upon the nuclei of both lead and aluminum. Chao, however, did not know that these were annihilation rays. This was first proved very beautifully by Jean Thibaud of Paris in 1933.

ARTICLE 8. In addition to the foregoing you may of course believe any direct experimental findings from which the personal equation and the judgment of the observer have been entirely eliminated. Many observers could show you such, and I wish to close this very brief statement of some of the articles that you may believe because of the vote of a jury by showing you a group of photographs that tell their own story quite independently of any interpretation which either I or the jury have brought in.

Through most of these photographs[2] you will be the direct witness of the terrible bombardment to which you and everything on this earth of ours is being continuously subjected by some unseen, universally distributed but largely unknown cosmic agency.

[2] These photographs are all found in a book issued in January, 1935, by the University of Chicago Press entitled, "Electrons + and −, Protons, Photons, Neutrons and Cosmic Rays."

CERTAIN ASPECTS OF GEOLOGIC CLASSIFICATIONS AND CORRELATIONS.[1] II

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In the tripartite division of the old Carboniferous into the Mississippian, Pennsylvanian and Permian systems the first division between the Mississippian and Pennsylvanian is seemingly based on sound grounds; but the present separation of the Permian from the Pennsylvanian has no such good basis. If we look to diastrophism as the ultimate basis for classification we naturally turn to the Asturian phase of the Hercynian revolution. Diastrophically this was the most pronounced of the several important manifestations of earth unrest during Pennsylvanian and Permian times. Was it also the most significant from the standpoint of its consequences—stratigraphic, climatic and biologic? This is the vital question, but one which, owing to its complexity and the lack of sufficient data, we are perhaps not yet ready to answer satisfactorily.

The Asturian orogeny broke out between the Westphalian and Stephanian of Western Europe or the Moscovian and Uralian of Eastern Europe. A marked stratigraphic break characterizes much of Europe. Where the corresponding formations are well displayed in Eastern Asia, a similar important gap in the stratigraphic column is likewise manifest. In China, the equivalent of the Uralian, separated from the underlying Middle Carboniferous by a pronounced unconformity, possesses a very different fauna which, however, is closely linked with the overlying Artinskian, classified as Permian. In India and South Africa, the Talchir and Dwyka tillites at the base of the Permo-Carboniferous sequence both rest upon very much older rocks, so that the time gaps in these regions are very much longer and definite knowledge of whatever diastrophic manifestations may have preceded the glaciation is wanting. More certain dating of these tillites is greatly needed, but the long time represented by the unconformities beneath is in itself of some significance. On the other hand, the history of Texas and adjoining region has been different. A relatively complete record of the Pennsylvanian and Permian is here the notable feature. No dominating conspicuous break is found within the existing Pennsylvanian-Permian stratigraphic column where those formations are best represented, though Hercynian deformation strongly affected other belts. Consequently, reasons have been advanced in this country for combining the Pennsylvanian and Permian into a single system. But European, Asiatic and Southern Hemisphere history was seemingly more significant at this time than North American.

As means of classification and correlation we have the orogenic movements, the regressions of the sea, the glaciation and the faunas and floras. The practical question arises: How closely synchronous were the orogenic movements and the regression of the seas in the most typical regions of the globe? Our chief method of determination is by the use of fossils. We rely principally upon them for dating formations and events. Where diastrophic episodes do not match closely in distant lands, according to fossil testimony, we are prone to assume that these physical events were somewhat scattered in time. Is this conclusion, however, necessarily true? May not the other alternative perhaps be true in many cases? May not the diastrophism have been relatively short-lived and more or less synchronous in the broader sense, while the seeming discrepancy in time lies principally in the fossil interpretations? Are the fossils *always* a better means of age determination and correlation than major diastrophic movements?

Let us consider fossil criteria for a moment. Age determination and correlations can be based upon the first appearance of certain forms of life which are taken to be of diagnostic significance, or they can be based upon the last stand of old forms, or upon the presence of certain short-lived, highly characteristic types or assemblages. If we utilize the first appearance of new forms, we face the problem of their migration from distant regions. So far as present information may be trusted, slowness of migration has apparently often been the case. This may have been a matter of slow travel, or of delay until the removal of barriers allowed the necessary spreading into the areas considered, or until slow physical changes in a given region made it a fit habitat for invasion by the forms of life in question. In many cases, the time required for the accomplishment of these things may have been very considerable, and the initial appearance of critical forms in two distant regions may have been at very different times. Furthermore, in addition to the true time difference, the discrepancy may appear still greater because of the well-known imperfections of our very fragmentary fossil records. The

[1] Address of the vice-president and chairman of the section on Geology and Geography, American Association for the Advancement of Science, Pittsburgh, December 31, 1934.

earliest of fossil finds may not represent the first invaders.

Favorable or unfavorable environmental conditions are very important in determining whether a given life assemblage will, or will not, inhabit two different areas at the same time. So also, hostile conditions have often caused the disappearance of certain types from some areas, while they linger long after in other areas of more genial climate, fewer enemies or other advantages.

When these important factors shall have been more fully worked out and better understood, and when our present patchy information shall have been greatly extended, as it will be in time, our paleontologic correlations will be much more reliable than they are today. Every little while the known range of a species or genus is extended rather surprisingly. Not infrequently two species, supposed to exist only in beds separated by many hundreds of feet of strata, are found together in the same hand specimen.

This is not an attempt to disparage paleontologic correlations, for their great value is universally recognized, but we must face the facts and maintain a proper open-minded reserve. It may well be that the major diastrophic movements were more nearly synchronous in different portions of the earth than some present fossil correlations would lead us to believe. That possibility must be kept in mind while awaiting fuller knowledge.

Likewise of importance in our problem is a more certain timing than we now have of the onset and main stages of the glaciation in Australia, South Africa, India and South America. The thicknesses of late Paleozoic glacial drift in these widely separated regions were so much greater than those of the Pleistocene glacial drift of Europe and North America, and the glaciers reached such incredibly low latitudes, that it seems reasonable to infer a general refrigeration of the earth's climate during the several stages of glaciation. The only alternative now apparent is to assume that the strongly glaciated areas were at those times located in the South Polar region—a view not favored for various reasons, not the least of which is the difficulty of explaining, on this hypothesis, the warm interglacial times between the glacial stages. If we believe in an underlying general cooling of the earth's surface and atmosphere, with special conditions of precipitation, atmospheric and ocean currents, etc., determining the loci of glacier development, the climatic factors must not only have been of great importance in leading to radical biologic changes, but the times of glaciation, ordinarily relatively short in duration, should have been roughly correlative in the different continents.

If we accept this view, another question confronts us. How closely was the glaciation related in time to the diastrophism, particularly the Asturian disturbance? It seems now that the first of these late Paleozoic glacial stages appeared approximately at the close of the Mississippian, which was characterized by the Culmide diastrophism. David and Süssmilch locate the second glacial stage of New South Wales high up in the thick Kuttung series, which they call Middle Carboniferous, and the third or Lochinvar glaciation at the base of the Kamilaroi (Permo-Carboniferous) system. According to their sections, the deposits of the second glaciation lie directly below those of the third (Lochinvar, Bacchus Marsh, Inman Valley) glaciation, though there is a break in the sequence and a marked floral change between them. At some time within this interval was the Asturian orogeny. The fourth and fifth Australian glacial stages occurred much later, in the Permian.

In India, the Talchir tillite has usually been placed after the Middle Carboniferous. In harmony with this, Grabau held in 1933 that the Talchir glacial beds of the Salt Range belong to the time of the Asturian folding and succeeding erosion. Du Toit believes that the Dwyka glaciation of South Africa, whose deposits he regards as unmistakably equivalent to the Sierra de la Ventana tillite of Argentina, began at the end of the Lower Carboniferous and terminated not later than the close of the Upper Carboniferous. His 1933 view was that the main Gondwana glaciation reached its maximum during the middle of the Upper Carboniferous (Westphalian-Moscovian) and that the only true Permian occurrences seem to be the minor ones of New South Wales and probably Bolivia.

From the writings of these authorities one would judge that an important Culmide glaciation occurred at the close of the Mississippian and another and more pronounced glaciation about the time of the Asturian orogeny. Schuchert, on the other hand, while in agreement on the Culmide glaciation, is strongly of the opinion that the Dwyka-Talchir-Lochinvar glaciation occurred long after the Asturian orogeny, in early Artinskian or early Middle Permian according to his classification. In this difference of opinion, we see the present status of the Permo-Carboniferous glacial problem.

Whether the Asturian phase of the Hercynian revolution should properly be raised to the importance of a division marker between geologic periods is therefore less a question for immediate decision than a working proposition to be tested with each new acquisition of relevant facts. Nevertheless, a movement toward utilizing this Asturian break between the Westphalian and Stephanian, or Moscovian and Uralian, as the division between the Pennsylvanian and the Permian is already apparent. As a result of

his recent wide studies in China, Grabau now definitely ends the Pennsylvanian with the Moscovian and starts the Permian with the Uralian. Schuchert, in his latest writing on the Permian, does likewise, though maintaining that the pronounced glaciation followed long after the beginning of the Permian.

If we entertain tentatively the proposition to begin the Permian with the Uralian, following the Asturian orogeny, the close of the Permian likewise merits consideration in rounding out the problem of that period. Lack of time, however, will allow only brief consideration of one possibility. The Saalian orogeny, after deposition of the Lower Rothliegende, caused an important break in the European stratigraphic succession and was followed by a flora of more Mesozoic aspect. As the authorities participating in the symposium before the British Association have considered this a more significant break than that between the present Permian and the Triassic, it may be that the most logical termination of a redefined Permian period is at the Saalian deformative episode. In the Eastern United States, the Appalachian revolution occurred after the Dunkard (Lower Rothliegende), though it is not yet certain just how soon after the Dunkard it actually took place. Should the Appalachian revolution prove to be equivalent to the Saalian deformation in Europe, this would be strong additional reason for placing a division between periods at that time. Therefore, as a working hypothesis to be given careful testing, we have the proposition that the Pennsylvanian end with the Asturian orogeny, that the Permian comprise the time from that deformation to the close of the Saalian disturbance (or Appalachian revolution), and that what remains of the present Permian after that be included in the Triassic, to which it is closely related.

This proposition, so briefly and inadequately treated here, leads to the final, still larger question: Where is the boundary between the Paleozoic and the Mesozoic, between ancient life and medieval life, most appropriately placed? Drawing it at the Saalian break is one alternative. In this case the Permian, between the Asturian and Saalian beats of the geologic rhythm, would constitute a transitional period completing the Paleozoic. General conservatism may militate against any more radical departure from our present classification than this. But, when everything has been considered, does such a step go far enough?

One of the principles of the general philosophy here followed is to go back to causes and beginnings. If we are correct in seeking the initiation of the newer order in the Asturian phase of the Hercynian revolution, that should seemingly have strongest claim as the natural starting point of the new era. On this basis, the Permian, with the beginning and early stages of the newer order of things, would belong to the Mesozoic.

The Mesozoic is the "Age of Reptiles." Outstanding in importance in that era, this great class overshadows all other animal groups. Already in the Permian the reptiles were strongly developed and considerably deployed. From the Pennsylvanian, however, they have not been reported in any great abundance. Very recently Professor Romer has been exploring the Upper Cisco beds of Texas with confident expectation of finding significant reptiles in those strata which have ordinarily been classed as Pennsylvanian. As the Upper Cisco, however, is correlated with the Uralian, these beds according to the classification here under consideration would belong to the early Permian. So far as we can judge at present, the first rise of the reptiles to power was not far removed in time from the Asturian orogeny, following which came their relatively rapid and very great development. Including, therefore, the post-Asturian Permian in the Mesozoic would make that era, in the truest sense of the expression, the "Age of Reptiles."

The keynote of this address may be taken to be an encouragement of efforts to bring greater harmony into our general picture of earth history. There is nothing new in the motive, nor is it taking a new tack to urge the cosmopolitan point of view against the provincial point of view. What has been presented merely reemphasizes some of the underlying philosophical considerations whose application is believed to be broader and of more general import than regional peculiarities and local details. Even so, perhaps too much uniformity is expected of so large a sphere as our earth; perhaps we shall find that there has been too much local variation in the behavior of different portions of its surface to allow completely satisfactory coordination of all into a single standard history. Possibly practical considerations will force us to recognize that a given geologic period, as best delimited in a certain area, actually began there earlier than it did in some other particular area, according to the most useful classification in that area. This address ends in the year 1934; Australia and Eastern Asia are already in the year 1935. We must take nature as it is. In any case, however, it is best to assume the attitude that geologic history can be treated satisfactorily on a world basis, and to proceed on that assumption until it shall be definitely and finally proved that Mother Earth has not shown sufficient system and order in her doings to give us a basis for a good universal classification.

OBITUARY

COLLIER COBB

COLLIER COBB, professor of geology at the University of North Carolina for forty-two years and head of the department of geology for thirty-nine years, died at Chapel Hill on November 28, 1934, after an illness of more than a year. Professor Cobb was one of the pioneers in North Carolina geology and the first to become head of the department of geology. Previous to that time geology had been chiefly taught along with chemistry or zoology by the professor, who was also state geologist, beginning with Denison Olmsted in 1824 (the first state geologist in the United States), and ending with Professor J. A. Holmes, who later resigned as state geologist to organize and become the first head of the U. S. Bureau of Mines.

After two years' study at Wake Forest College and one year at the University of North Carolina, Professor Cobb entered Harvard University, where he took his A.B. and M.A. degrees. For two years before going to the University of North Carolina he served as instructor in the Massachusetts Institute of Technology.

Professor Cobb has a notable record as an enthusiastic and inspiring teacher. He believed that the spirit of the subject was more important than the letter, and with this same appreciation many of his students have gone out into positions of responsibility and honor.

Professor Cobb was a native of North Carolina and was noted for his devotion to his state and its institutions, but this fact did not in any way limit his keen interest in travel and in world affairs and he was nearly as well known abroad as in the United States. His striking personality, keen intellect and remarkable memory, coupled with a wealth of rare anecdotes, made him a central figure in any group.

In his studies Professor Cobb covered a wide field of thought, although his greatest interest was in the work of the wind in desert and shore areas, as is indicated by: "Where the Wind Does the Work," "Lands and Dunes of Gascony" and the "Loess Deposits of China." Because of his travel and great interest in peoples and customs he will, perhaps, be best remembered in the scientific world as a human geographer and as a student of shore-lines and shoreline processes. Most of his scientific publications deal with one or the other of these two subjects.

The early intellectual development of Professor Cobb was remarkable. At the age of nine years he began the publication of *The Home Journal* in Shelby, N. C. He was editor, illustrator, printer and distributor. Many of the illustrations were drawn on wood blocks for printing and showed marked artistic ability.

Professor Cobb was such a keen observer of people, languages and customs and so well acquainted with different types of people that he was usually able to tell from what country and frequently from what province a foreigner had come. When meeting a new class for the first time it was his custom, as students responded to the roll-call, to tell them the state they came from and the county, if from North Carolina, and frequently much about their people.

Professor Cobb was a fellow of the Geological Society of America and a member of many societies, including the American Association for the Advancement of Science, the Association of American Geographers, the Boston Society of Natural History, the American Institute of Mining and Metallurgical Engineers, the Seismological Society of America, the Elisha Mitchell Scientific Society, the North Carolina Academy of Science and Sigma Xi.

Professor Cobb resigned as head of the department of geology in 1932 and began the preparation of a book of reminiscences. It is very unfortunate that he did not live to finish this work, which held so much of interest for many people here and abroad.

WM. F. PROUTY

THOMAS HUSTON MACBRIDE

IN the death of Thomas Huston Macbride society lost a useful citizen, university life lost an inspiring leader, and science lost an able and devoted worker. He sold the idea of beauty to the people of Iowa, showing them how the ugly could be transformed to the beautiful. A striking example of this was his successful efforts in beautifying public squares, parks and cemeteries in communities throughout the state. He saw beauty, actual or potential, everywhere. Whether in the prairies, streams, lakes and groves of Iowa, the desert regions of the Southwest, or the mountains, shores and evergreen forests of the Northwest he always saw beauty as he went about his scientific work, and aroused enthusiasm for preserving this beauty and for restoring it where it had been destroyed. He saw beauty in the cabins and sod houses of the Iowa pioneers.

In his academic life his high personal ideals, his kindness and the beauty of his teaching had effects on his colleagues and his students which will last a long time. To his students he taught more than botany: he taught ideals of life and appreciation of beauty. Many took his courses, not because they wanted botany, but because they wanted to sit in the presence of a great personality.

Born at Rogersville, Tenn., on July 31, 1848, the son of a minister, he went with the family by wagon

to Iowa in 1854. There the family lived on the prairie and Thomas, the oldest of the children, worked all week for neighbors and came home on Sunday for religious worship and training. He was at Monmouth College from 1865 to 1869, studying mainly Latin, Greek, Hebrew, French and Bible. He took only one year of science (botany and physiology). He received the following degrees—A.B., Monmouth, 1869; A.M., 1873; LL.D., 1914; Ph.D., Lennox College, 1895; LL.D., Coe College, 1915. In 1891 he studied in Strasburger's laboratory at the University of Bonn, and also visited Pasteur's laboratory at the Institute in Paris.

He was professor of mathematics and modern languages at Lennox College (Hopkinton, Iowa) from 1870 to 1878. At the State University of Iowa he was assistant professor of natural science from 1878 to 1884, professor of botany from 1884 to 1914, and president from 1914 to 1916. He was president emeritus of this university from 1916 to the time of his death. He lived in Seattle from 1924 to the time of his death on March 27, 1934. For several years previous to 1924 he had divided his time between Iowa City and Seattle.

In science his contributions began with his trips over the prairies of Iowa on foot and by team with his lifelong friend, Thomas Calvin, for the study of geology and botany, and were continued in his trips to the southwestern and northwestern United States and also to Mexico and Europe. Outstanding accomplishments of his scientific career were his field collection of Cycads, his special study of slime moulds, and his establishment of the Lakeside Laboratory at Lake Okoboji, Iowa. In June, 1934, the University of Iowa commemorated his service there by naming the natural science building Macbride Hall.

Among his professional publications are numerous chapters in the Reports of the Iowa Geological Survey, papers in the Proceedings of the Iowa Academy of Science, his "Text-book of Botany," the three editions of his "North American Slime-Moulds," and "The Myxomycetes"; a descriptive "List of the Known Species with Special Reference to those Occurring in North America." The last, in collaboration with Dr. G. W. Martin, was published after Dr. Macbride's death. Other tangible results of his work are his collections of plants distributed to various herbaria, the fossil Cycads which he discovered in the Black Hills of the Dakotas and distributed to the British Museum and other institutions, and the teaching and research facilities available at the Macbride Lakeside Laboratory on the shore of Lake Okoboji in northern Iowa.

Many of his public addresses were published, and he wrote, by request, many newspaper articles dealing with the state of Iowa and its university. Two volumes of his addresses (1916 and 1925) were published under the title "On the Campus." His sympathetic interpretation of the life and ideals of the early pioneers of Iowa found expression in his volume "In Cabins and Sod Houses" (1928). He also published notes on his experiences at Bonn and various travel notes.

It was my privilege to know Dr. Macbride over a long period of years, and I owe much to the influence of his charming personality, the breadth of his scholarship, his love of nature, his skilful teaching and his enthusiasm for research. It was he who, in my freshman year, first gave me an insight into the field of botanical science, and it was he who, in the years when he was growing old beautifully in Seattle, was still a valued friend and counselor.

GEO. B. RIGG

SCIENTIFIC EVENTS

TELEVISION IN GREAT BRITAIN

THE London *Times* reports that a television advisory committee has been appointed by the postmaster-general to cooperate with the British Broadcasting Company in the inauguration of public television service.

The question of a suitable site for the London station is an important one. To ensure a sufficiently large area of service it is essential that the sending aerial of the station should be on an elevated site, since, in the case of the ultra-short waves to be used, it is necessary to have a substantially uninterrupted path between the sender and receiver. It is also desirable that the sending station should be in the center of a densely populated area.

One of the best sites is at the top of the Crystal Palace Tower, which has been used since June, 1934, for experimental and developmental work, and is now fitted with the required studios and laboratories. Vision signals are now sent out on a wave-length of 7 meters, while the accompanying sound is radiated on 8.5 meters, and demonstrations of satisfactory reception of both vision and sound have been given at places as far as twenty-five miles from the Crystal Palace.

Two new Baird home televisors have been demonstrated on the Crystal Palace signals. One model showed a brilliant black and white picture 8 inches by 6 inches in size, while the *de luxe* model gave a picture of 12 inches by 9 inches, suitable for an audience of thirty people.

Baird Television, Inc., has also demonstrated the

transmission of scenes by the intermediate film process. By means of it a talking film of an event is recorded and subsequently used for vision and sound transmission. The developing, fixing and washing of the film are carried out so expeditiously that there is a delay of only 30 seconds between the film recording and the television transmission.

The Marconi-E.M.I. Television Company, who, with Baird Television are to be invited to supply television senders for the new London station, have television receiving sets ready for the market, but point out that radio sound broadcasting will dominate the programs for many years and that television will not in any way interfere with the developments in radio sound broadcasting with its ever-increasing entertainment value.

EXHIBIT OF MINERALS AT THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

FIFTY minerals, prepared by Miss Mary Allison Reed, of the staff of the Academy of Natural Sciences of Philadelphia, have been placed on exhibition in the mineral hall of the natural history museum.

The minerals, which are displayed on a black felt-covered panel around a road-map which shows the source of the specimens, have been gathered in quarries and mines near Philadelphia and from the rocks exposed along the Wissahickon and nearby streams. Ten localities, typical of those with similar underlying rocks but most prolific of their type, are represented in the collection.

The localities and the minerals are as follows:

(1) French Creek iron mines, 8 miles southwest of Pottstown: pyrite, chalcopyrite, calcite, apophyllite, magnetite, byssolite.
(2) Perkiomenville, Kibblehouse crushed stone quarries: calcite, stilbite, chabazite, natrolite, heulandite, epidote, garnet.
(3) Wheatley lead and zinc mines, 2 miles south of Phoenixville: quartz, calcite, ankerite, galena, sphalerite, fluorite, cerussite, anglesite.
(4) Railroad cut west of Henderson Station (near Bridgeport): quartz crystals, limonite.
(5) Soapstone quarries below Miquon (Lafayette): serpentine, chlorite, dolomite, talc, hornblende, magnetite.
(6) Rocks along Wissahickon, 500 feet north of Devil's Pool: anthophyllite, cyanite, garnet, staurolite.
(7) Vanartsdalen's quarry, 2 miles north of Neshaminy Falls: blue quartz, pyroxene, orthoclase, amphibole, wernerite, wollastonite, graphite, zircon, titanite, apatite, pyrrhotite.
(8) Brinton's quarries, 3 miles south of West Chester: serpentine, albite, magnesite, magnetite, asbestos, clinochlore, jefferisite.
(9) Rocks in creek and hillside of Mineral Hill, west of Ridley Creek (Media): serpentine, deweylite, sunstone, moonstone, amazonstone, chromite, enstatite, actinolite.
(10) Leiper's quarry, Crum Creek near Swarthmore: quartz, microcline (feldspar), muscovite and biotite (micas), beryl, tourmaline, garnet.

AWARDS OF THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

THE American Institute of Mining and Metallurgical Engineers held its annual meeting in New York on February 19 and 20. The Howe Memorial lecture was given by Earl C. Smith, chief metallurgist of the Republic Iron and Steel Company, who discussed the effect of the application of petrography on the production of steel.

An international symposium on geophysics included papers by Rudolph Krahmann and Leopold Reinecke, of Johannesburg, J. G. Sineriz, of the Spanish Geological Survey, and Howard I. Smith, of the United States Geological Survey.

Medals for distinguished work in mining and metallurgy were presented. James MacNaughton, president and general manager of the Calumet and Hecla Consolidated Copper Company, received the William Lawrence Saunders Gold Medal for his work in the field of copper mining.

The James Douglas Medal for distinguished achievement in non-ferrous metallurgy was awarded to George C. Stone, author of numerous papers on this subject and an authority on the extraction of zinc.

The J. E. Johnson, Jr., Award was given to Francis M. Rich, of the Republic Steel Corporation, Youngstown, Ohio, for his work in the development of blast furnace operation under conditions of slow blowing.

Thomas Arthur Rickard, of Victoria, B. C., Canada, received a certificate of honorary membership in recognition "of his outstanding achievement as a proponent and preceptor of advance standards in technical concept and writing, and his brilliant contributions to the literature of geology, mining and metallurgy, as editor, journalist and author."

Six men who have been members of the institute for fifty years received the insignia of the institute's Legion of Honor. They were: Arthur S. Dwight, Arthur L. Walker, H. L. Hollis, L. W. McKay, C. Snelling Robinson and H. H. Webb.

Howard N. Eavenson, retiring president of the institute, presided. Dr. Henry A. Buehler, director of the Missouri State Bureau of Geology and Mines, was elected to succeed him. Other officers elected were: *Vice-presidents,* John M. Lovejoy and Paul D. Merica; *directors,* Dr. Charles K. Leith, Edwin E. Ellis, Wilber Judson, Wilfred Sykes and R. M. Roosevelt.

THE HARVARD ARCHEOLOGICAL EXPEDITION TO VENEZUELA

DR. ALFRED V. KIDDER, honorary curator of southwestern American archeology of the Peabody Museum of Archeology and Ethnology, Harvard University, has returned from Venezuela, where he directed the archeological researches of the expedition sent into the field by Harvard University. Excavations were carried on at Los Tamarindos on the peninsula of La Cabreria, Lake Valencia, and also in the desert and Andean regions west of Lake Valencia.

The *Boston Evening Transcript* reports that cultural remains were found in two distinct layers at Lake Valencia. An early civilization was in evidence in stratified layers of sand and gravel which extended from three feet below the surface of the earth to a depth of twenty-five feet or more; a succeeding civilization was discovered in the topsoil, or humus cap, three feet thick at the earth's surface. Dr. Kidder found practically no relation between the two civilizations, indicating possibly that the earlier civilization was wiped out by the inroads of a hostile tribe, and the pottery has so far yielded little evidence as to their identity. The tribe originally holding the site may have been a branch of the great linguistic group of Indians named the Arawaks, whose occupancy probably began about A. D. 1000. The invaders may have been a part of the linguistic group known as the Caribs, who possibly originated in the vicinity of the River Xingu, Brazil.

The view that the Caribs drove the Arawaks out of this region is supported by an archeological opinion of long standing that two or three centuries before the Spanish conquest of the territory there was a large Carib migration to the north, reaching as far as the Greater Antilles and perhaps even to Florida. Dr. Kidder notes, however, that the picture is far from complete, since he found that as late as 1880 Indians in the Lake Valencia vicinity still spoke the Arawak dialect. Whatever tribe held the Lake Valencia site at the time of the Spanish invasion, however, was completely wiped out.

The earlier civilization was characterized by the practise of primary burial. Bodies were buried immediately after death and left undisturbed. Pottery vessels, some of coarse material roughly made, others of fine clay, polished and decorated, were found in the graves, as well as pipes, carefully and highly decorated. These were of special interest because they seemed to have no relation to others found in the vicinity.

The first culture appears to be totally unrelated to the later civilization on the same site. Secondary burial was practised by the later inhabitants. Bodies of the deceased were exposed, and the bones were rearranged in a particular manner in funeral urns of pottery. These pottery vessels showed characteristics distinct from those of the earlier period, but similar in some respects to those found in Central America, Brazil and the Antilles.

On a reconnaissance expedition through western Venezuela, Dr. Kidder found further fragmentary evidence of the relationships between the Indian tribes of the second period, but none with those of the earlier period. A rich archeological deposit was discovered in the Carache Valley, the sides of which, though heavily eroded, were covered with a mass of potsherds. The people of this region practised primary burial. Their pottery, hard, well-fired and intricately decorated, showed them to be distinct from any civilization previously found. Attempts at archeological research in Barquisimeto and near Merida gave few results, as little remained *in situ,* but a study of private collections in these vicinities showed a relation between the Andean culture and that of regions to the west.

THE THOMAS ALVA EDISON FOUNDATION

THE Edison Pioneers, a group of former associates of the late Thomas A. Edison, met on February 11 to commemorate the eighty-eighth anniversary of the inventor's birth. According to the *New York Herald Tribune,* William S. Barstow, president of the group, announced that the formal incorporation of the Edison Foundation, deferred since 1932, would be carried out this year.

In 1932, the Edison Pioneers and the American Institute of Electrical Engineers formed a joint committee, the International Edison Foundation, a permanent foundation to collect funds for the establishment of memorials and scientific fellowships in Mr. Edison's honor.

Eighty of 100 leaders of industry and finance who were interviewed during 1933 were of the opinion that Mr. Edison's work should be recognized by the public in some substantial manner. The other twenty held that every incandescent lamp, phonograph, motion picture or radio set was in effect an Edison memorial. The committee, however, agreed that the progress of technical invention might leave all these devices outmoded and forgotten.

As a result of conferences with the International Electro-Technical Commission and with prominent men in this country, action was postponed until 1935 because of adverse economic conditions, but the committee has now decided to incorporate in the near future under the name of the Thomas Alva Edison Foundation. Trustees of the foundation will include members of the committee and representatives of the

Edison State Park Commission of New Jersey, the Association of Edison Illuminating Companies and the Edison family.

Detailed plans will not be announced until after the incorporation has been completed, but it is intended to designate the week of October 14 as Edison Memorial Week and to have a campaign at that time to raise an endowment fund for the foundation.

Mr. Barstow was reelected president of the Edison Pioneers. Other officers named were: *Vice-presidents,* Charles Edison, Frederick D. Potter, Arthur Walsh and Ludwig F. Ott; *historian,* William H. Meadowcroft; *treasurer,* Frederick A. Scheffler, and *secretary,* Frank A. Wardlaw.

FELLOWSHIPS OF THE AMERICAN ASSOCIATION OF UNIVERSITY WOMEN

THE American Association of University Women has announced the award of ten research fellowships to women for the coming year. Five of the fellowships will be used for scientific research. The awards were made by a committee of which Dr. Emilie J. Hutchinson, associate professor of economics at Barnard College, is chairman.

Dr. Jenny E. Rosenthal, research physicist at Columbia University, who received the Sarah Berliner research fellowship, has been working for a year in the laboratory of Professor H. C. Urey, winner of the 1934 Nobel Prize in chemistry for his work with heavy water, and will continue her work there.

The Latin-American fellowship was given to Dr. Perlina Winocur, physician on the staff of the University of Buenos Aires Medical School. The award is offered annually by the association to give a qualified woman of Latin America a year of study in the United States. Dr. Winocur has devoted several years to a study of infant mortality in Argentina. She will continue her studies on hemolytic anemia next year at the Harriet Lane Home for Children, the Johns Hopkins Hospital, where she has been working during the past winter.

The Mary Pemberton Nourse memorial fellowship was given to Lucy S. Morgan, health education specialist in the Tennessee State Health Department, who will study the science of public health at Yale University, after which she plans to resume her work in Tennessee.

Mary S. Pease, a student in archeology and recipient of the Alice Freeman Palmer memorial fellowship, plans to write a monograph on Corinthian imitations of Attic pottery. Dr. Pease has spent three years with the American School of Classical Studies at Athens, working on excavations in Athens and Corinth.

The award to a university woman of some foreign country was given to Dr. Gertrud Kornfeld, a German refugee and former lecturer of University College, Nottingham, England, who has won recognition for her research in photochemistry. She will hold her fellowship at the University of Vienna.

SCIENTIFIC NOTES AND NEWS

DR. ISAIAH BOWMAN, director of the American Geographical Society and chairman of the National Research Council, has been elected the fifth president of the Johns Hopkins University. The announcement was made by Daniel Willard, president of the board of trustees, at the fifty-ninth commemoration day exercises of the university on February 22. Dr. Bowman will succeed Dr. Joseph S. Ames, who will retire on June 30 after having been connected with the university for fifty-two years.

DR. WILLIAM H. WRIGHT, astronomer at the Lick Observatory, was appointed director of the observatory on February 24 by the board of regents of the University of California. Dr. Wright, who has been a member of the staff of the university for thirty-eight years, will begin his duties as director on July 1. He succeeds Dr. Robert Grant Aitken, a member of the observatory staff for forty years and director since 1930, who is retiring from active duty.

DR. GEORGE R. WIELAND, research associate in paleobotany at Yale University, has received notification from Dr. Birbal Sahni, of Lucknow University, of his election as an honorary member of the Indian Botanical Society.

DR. HARRY PLOTZ, formerly research chief of the Pasteur Institute and member of the Pierre Curie Institute of Paris, has been promoted from chevalier to officer of the Legion of Honor. Dr. Plotz, discoverer of the typhus fever germ and leader of the group which fought the typhus fever epidemic in Serbia during the world war, was the first American to be appointed a member of the permanent staff of the Pasteur Institute.

AT the quarterly meeting of the council of the British College of Obstetricians and Gynaecologists it was decided to confer the honorary fellowship upon Nagiub Mahfouz Bey, of Cairo.

THE Cameron Prize of the University of Edinburgh for 1935 has been awarded to Professor Julius Wagner-Jauregg, emeritus professor of psychiatry and neuropathology in the University of Vienna, in recognition of his discoveries regarding the malarial treatment of general paralysis.

MAJOR WILLIAM E. KEPNER, Captain A. W. Stevens, Captain O. A. Anderson and Mrs. Jeanette Piccard received certificates of award on February 19 from the National Aeronautic Association for their stratosphere flights.

DR. HAROLD H. PLOUGH, Rufus Tyler Lincoln professor of biology at Amherst College, has been granted a sabbatic leave for the current semester. Dr. Plough will spend a part of his time at the Bass Biological Laboratory in Englewood, Fla., in the study of marine fauna, followed by four months in the laboratory of the California Institute of Technology at Pasadena, where he will devote himself to genetics, particularly experiments with the heredity of the fruit-fly. Before returning to Amherst in the autumn, he expects to continue his research at the Marine Biological Laboratory in Woods Hole.

PAUL G. REDINGTON, formerly chief of the bureau of biological survey of the U. S. Department of Agriculture, has been appointed forest supervisor of the Shoshone National Forest, Wyoming.

DR. RODERICK MACDONALD, assistant professor of zoology at Harvard University, was appointed director of the Philadelphia Zoological Gardens on February 13.

DR. R. BINFORD has retired from the presidency of Guilford College, North Carolina, and has resumed the professorship of biology.

DR. MATTHEW A. HUNTER, professor of electrochemistry at Rensselaer Polytechnic Institute, has been appointed head of the newly created department of metallurgical engineering.

DR. P. R. WHITE, for the past two years fellow of the Rockefeller Institute for Medical Research, has been appointed a member of the staff in the department of animal pathology of the Rockefeller Institute at Princeton, N. J.

DR. EUGENE E. GILL, associate professor of chemistry at the Armour Institute of Technology, has retired.

DR. W. W. COBLENTZ, chief of the division of radiology of the U. S. Bureau of Standards, is spending part of the winter at the School of Tropical Medicine in Puerto Rico, measuring the ultra-violet intensity of the sun and standardizing the equipment to be used in the study of tropical physiology. Dr. Coblentz gave a lecture before the staff of the school on "The Problem of Evaluating Ultra-violet for Use in Medicine."

DR. WILLIAM W. STIFLER, professor of physics at Amherst College, has been granted leave of absence for the second semester of 1934–35. He has planned visits to physics laboratories in France, Italy, Switzerland, and possibly Germany, with a three-months stay in England, where he will read and attend lectures at the University of Cambridge.

MELBOURNE A. CARRIKER, JR., in charge of Central and South American ornithology at the Academy of Natural Sciences in Philadelphia, returned on February 20 from a seven months' expedition into the jungles of Bolivia, where he collected 2,200 bird skins. The collection includes more than 600 species, of which 150 have never before been recorded.

DR. C. A. EDWARDS, metallurgist and principal of University College at Swansea, South Wales, recently arrived in the United States. He will lecture at the Carnegie Institute of Technology, Yale University, the Franklin Institute and the U. S. Bureau of Standards.

DR. GARY N. CALKINS, professor of protozoology at Columbia University, is conducting a protozoological survey of the mammals of Puerto Rico during his visit at the School of Tropical Medicine. He lectured recently on "Protoplasmic Longevity with Special Reference to Protozoa" before the staff of the school.

A SERIES of four weekly lectures on the racial origins and composition of the principal nations of the world was delivered during February by Dr. Aleš Hrdlička at the U. S. Navy Medical School, Washington, D. C.

DR. WILLIAM P. MURPHY, of the Harvard Medical School and co-winner of the Nobel prize in physiology and medicine, spoke on February 8 before the Greater New York Dietetic Association on his work with pernicious anemia.

REV. JAMES B. MACELWANE, professor and director of the department of geophysics at St. Louis University, delivered his third Lowell Institute lecture in Boston on February 8. His subject was "Some Old Seismological Problems and Recent Solutions."

DR. HARLAN T. STETSON, research associate of the institute of geographical exploration at Harvard University, will give the Sigma Xi address at the University of Virginia on March 11 and at Duke University on March 12. His subject for both lectures will be "The Sun's Effects on Human Affairs."

THE ninth annual Priestley lectures will be given at the chemistry amphitheater at the Pennsylvania State College each evening from April 29 to May 3, inclusive. These lectures constitute a memorial to Joseph Priestley, whose old home at Northumberland, Pa., is now owned and maintained by the alumni of the college. A museum, containing all the Priestley relics which could be gathered together, now stands near the house. This annual series of lectures was inaugurated by the faculty in 1926. In 1931, Phi

Lambda Upsilon, honorary chemical society, undertook the financial support of the Priestley lectures. Each year the lectures deal with the borderline between physical chemistry and chemical physics and some other branch of knowledge. This year's Priestley lectures deal with the borderline between physical chemistry and electrometallurgy. They will be given by Matthew A. Hunter, D.Sc., professor of electrochemistry and head of the department of physics and electrical engineering at the Rensselaer Polytechnic Institute. The subjects of his five lectures are as follows: April 29, "Reactions in the Liquid State"; April 30, "Reactions in the Solid State"; May 1, "Physical Properties of Alloy Systems"; May 2, "Physical Properties"; May 3, "Special Applications."

THE fifth lecture of the Harvey Society was given by Dr. E. C. Dodds, director of the Courthauld biochemical laboratory of the Middlesex Hospital, London, on "Specificity in Relation to Hormone and Other Biological Reactions" at the New York Academy of Medicine on February 21. The sixth lecture on March 21 will be given by Professor G. V. Anrep, professor of physiology, Egyptian University, on "The Relation of the Circulation in Voluntary and Plain Muscle to Activity."

THE annual meeting of the Kentucky Academy of Science will be held on May 3 and 4 at the University of Kentucky. Titles for papers to be read at the meeting should be sent to the secretary, A. R. Middleton, Experiment Station, Lexington, Ky., not later than April 10.

ATTENTION of investigators is called to the fact that, owing to the decreased resources at the disposal of the committee on grants-in-aid of the National Research Council (see SCIENCE for January 18, 1935), the committee will hold but one meeting this year, about the middle of May. Applications to be considered at this meeting must be in the hands of the secretary of the committee, Dr. C. J. West, 2101 Constitution Avenue, Washington, D. C., on or before April 1. Applications received after the first of April can not be considered until the spring of 1936.

THE liquid air and chemical demonstrations which were exhibited in the Hall of Science, at the Century of Progress Exposition, will be demonstrated by Dr. Alden G. Greene, at a meeting of the American Institute on March 4 at the American Museum of Natural History, New York.

IT was announced on February 14 that a congress of physicians will be held on the steamship *Columbia* of the Panama Pacific Line from July 18 to August 28 under the auspices of the Pan American Medical Association. The itinerary calls for a 12,000 mile cruise, during which scientific meetings in all branches of medicine will be held. Stops will be made at Havana, Curaçoa, Rio de Janeiro, Santos, Trinidad, Santo Domingo and Kingston. A five-day scientific congress will be held at Rio de Janeiro and a three-day session at Sao Paulo. The officers of the organization are as follows: Dr. Chevalier Jackson, president of the association; Dr. Joseph Jordon Eller, director general; Dr. Charles H. Mayo, president of the section on general surgery; Dr. Harlow Brooks, general medicine; Dr. Charles Dennie, dermatology and syphilology; Dr. P. J. Flagg, gas therapy.

THE Belgian government has by royal decree officially recognized the International Office for the Protection of Nature, and has appointed the following delegates as its representatives to the general council: for Belgium, Baron E. de Cartier de Marchienne, Belgian ambassador in London, and Count Henry Carton de Wiart, formerly prime minister; for the Belgian Congo and the mandated territory of Ruanda-Urundi, P. Charles, minister of colonies, and Dr. V. Van Straelen, director of the Royal Belgian Museum of Natural History and president of the institute for national parks in the Belgian Congo.

A UNITED PRESS dispatch reports that on December 18 the National Geographic Society announced plans for another stratosphere balloon flight from the Dakota Black Hills for next June. Captain Albert W. Stevens, scientific observer and aerial photographer, will be in command of the balloon, piloted by Captain Orvil A. Anderson. Both officers participated in the ill-fated ascent of the *Explorer* last July when it attained a height of 11¾ miles only to tear. All three occupants parachuted to a safe landing. Major William E. Kepner, who commanded this year's flight, will be unable to take part because of Army air corps duties. His place probably will be taken by Lieutenant Randolph P. Williams, Langley Field, Va. The National Geographic Society will assume the major portion of the expense while the Army Air Corps, with the approval of the War Department, will supply the officers. Dr. Gilbert Grosvenor, president of the society, is reported to have said that the objects of the flight would be fourfold: To check and test stratosphere data already obtained; to make additional photographic studies; to bring back samples of stratosphere air, and to make certain other new scientific studies.

ACCORDING to a summary given in the *Journal* of the American Medical Association, there were 2,064,944 births in continental United States in 1933, giving a rate of 16.4 per thousand of population, the lowest on record since the federal birth registration area was established in 1915, when it included only ten states and the District of Columbia, according to provisional statistics issued by the Bureau of the Census. This

figure compares with a rate of 17.4 for 1932 for the birth registration area, which at that time did not include Texas. In 1933 the infant mortality rate was 58.2 per thousand live births as compared with 57.6 in 1932. New York with 187,139 births led the states with the greatest number of births; Pennsylvania was second with 157,046; Texas is third with 107,924, and Illinois, 106,861. The states with the highest birth rates per thousand of population, however, are New Mexico, 26.7; North Carolina and Utah, each 22.9; South Carolina, 22.7; Mississippi, 21.6; Alabama, 21.1, and Virginia, 21. All except Utah are southern states and all largely rural. The lowest birth rates are for Oregon, 12.2, and California, 12.4. Infant mortality rates, which are based on the number of deaths of infants under 1 year of age per thousand live births, are excessively high in New Mexico (134.2), and Arizona (111.4), both states with large nomadic Indian and Mexican populations which have little knowledge of infant care. The next highest rate is 78.4 for South Carolina, which has a large Negro population. The lowest rates reported are those for Washington and Oregon, 38.9 and 39.3, respectively. A rate of 3.7 per hundred live births was noted for stillbirths.

Nature states that a new high-voltage laboratory at East London College enables that institution to offer greatly improved facilities for study and research in this branch of electrical engineering. Towards the cost of its erection and equipment the court of the university made a grant of £12,000 and the Drapers' Company gave £5,000 and lent another £5,000 to enable the college to proceed at once with this and other enterprises. The calendar for the present session announces that the equipment will include a 500,000-volt testing transformer, a surge generator with a maximum capacity of a million volts, a direct-current generator of 200,000 volts capacity, a cathode ray oscillograph recording surge voltages up to a million volts, Schering bridge for measurement of dielectric losses, and transformers of 30,000–250,000 volts capacity for experiments. A course in high-voltage technology for degree students is being introduced under the direction of Professor J. T. MacGregor-Morris.

AT a recent meeting of the administrative council of the Empire Cotton Growing Corporation it was reported that news was received in July of a serious misfortune at the cotton breeding station at Gatooma, where a considerable quantity of pedigree cotton seed was destroyed in a fire. As a result, it was believed that only about half the quantity that would have been distributed to growers next season was now available. The report noted that a new hybrid cotton, grown in Fiji, which, it had been hoped, might be comparable with Sakel, when tested this year was found still to lack strength, and it was doubtful therefore if it would find a market at a remunerative price. The executive committee announced a decision to increase the grant made by the corporation to the funds of the Shirley Institute from £1,000 to £3,000 a year for a period of five years. The director, in a comment on the report, said that in Swaziland cotton was now being encouraged by the administration as a native crop. Apart from the cash value of the crop, the inclusion of cotton in a rotation would do much to improve the native system of agriculture, which hitherto had been one of almost continual cereal cropping. The corporation's staff were supervising the work of the native demonstrators who were assisting in the introduction of the crop.

THE London *Times* reports that an ethnological expedition, headed by M. Marcel Griaule, which proposes to study the religion, customs and life of the inhabitants of the district in the northern loop of the Niger, left Paris, France, on January 17. The expedition, which has been largely financed by Princess George of Greece, will travel in light motor-lorries, and will go by way of Algiers, Colomb-Bechar, Tamanrasset, and Gao to Timbuctoo. The other members of the party are M. Schaeffner, music, M. Larget, topography, M. Lutten, photography and native crafts, the Comtesse de Breteuil, Mme. Hélène Gordon, and Mlle. Paulme and Mlle. Lifszyc. The French Air Force at Gao has been instructed to put an aeroplane at the disposal of the expedition for its topographical work.

NEW fields of cotton research are to be explored in England as a result of a £30,000 increase in the annual grant for this purpose from the cotton trade, we learn from the *Christian Science Monitor*. This development was announced at the annual meeting of the British Cotton Industry Research Association in Manchester, when H. R. Butterworth, who presided, said that it had been decided that there must be no cutting down of the service essential to the industry to-day, and no neglect of fundamental research and advised that an expenditure of £82,000 per annum on cotton research will be necessary. The advisory council of the Department of Scientific and Industrial Research, Mr. Butterworth continued, had undertaken to make further grants for five years, dependent on the support given by the trade. Conditional on the annual income of the association from the trade and other approved sources reaching £37,500 per annum for cotton research, the Government would make an annual block grant of £15,000, with further £500 for every £500 in additional trade subscriptions up to a maximum additional grant of £20,000 for each year. This meant a minimum grant of £15,000 and a maximum grant of £35,000 against a maximum grant last year of £10,000.

DISCUSSION

ATTITUDE MEASUREMENT AND "THE DUNLAP DILEMMA"

ON pp. 207–8 of Dunlap's "Civilized Life," occurs the following:

> Ask an adult what he would choose if he were offered the alternatives of total annihilation, or of beginning his life over again, living it up to the present moment exactly as he has lived it, to face again the same alternatives. Make it clear that he is not, in his second life, to be allowed to profit by what he has experienced in the first; and the answer almost always is that he would choose annihilation.

The statement has far-reaching implications, and its casual mention among local colleagues elicited questioning reactions; which interested the writer in briefly reviewing the topic, with the sources nearest to hand. Accordingly a form was prepared, designed to represent fairly the conditions recited in the quotation above. After slight verbal changes, its uniform text was as follows:

Name is not needed..... Date..... Group.....
This inquiry is made to test the validity of a statement occurring in a standard psychological work.
Assume that you are offered your immediate choice of the following:

.....(A). To be totally annihilated.

.....(B). To begin your life over again, and live it up to the present moment *exactly as you have lived it, not profiting by any experience of your former life,* and then to be given the same choice of repeating your life, or annihilation.

Put a check mark before whichever alternative you would prefer.

The form was presented in such a way that no one needed to identify the answer, though actually this was often done. Uniformly successful effort was, however, made to obtain record of sex and age to nearest decade. Rationalizations, "unconscious determinants" and various questions of definition are not considered here, the concern being limited to the verbal choice under the assigned conditions. For convenience, choice of annihilation may be termed the "A" response, choice of reliving, the "B" response.

Mainly through the interest of colleagues,[1] whose help is here gratefully acknowledged, were assembled the 121 cases that form the basis of the present note. The material is highly selected; the majority are in the upper 5 per cent., and there is probably no one outside the upper 10 per cent. of measurable "intelligence." Almost all are in the third and fourth decades of life, and they are mainly hospital and university personnel. The data as here gathered show as a whole some one out of six A responses (20 of 121); whereas Dunlap indicates a marked preponderance of A responses. Data from persons over fifty should be of relative interest, but are here nearly absent. Any indications of sex difference should probably be looked on as of culture rather than sex.

The response is a function of the way the person feels adjusted to life as a whole. The largest proportion of A responses, one in three, actually occurs in that one of the groups living under the greatest socio-economic frustration. Another sample, of relatively favored status, yields but one A response in fourteen. The factor of reliability also enters; a cycloid personality would fluctuate in response, a schizoid maintain it. The amount of alcohol in the system, and like factors, should be potent, if temporary determinants. There is some reason to believe that various group pressures inhibit the A response, with its vote of no-confidence in the universe; a reason for "secret-ballot" procedure.

There is a sample of 23 cases, additional to the above, consisting of college undergraduates, not chronologically "adult." Their proportion of A responses is 6 cases. A further sampling, of 32 student nurses, ages ranging from 18 years up, yields four A responses, distributed as to age. In the total material, 176 cases, of whom it is safe to consider all as more than average adult in respect to "intelligence" at least, the A responses total 30. The possible rôles of I.Q., sex, socio-economic milieu, etc., require larger material for their elucidation.

It is a matter of some interest that such an apparently similar formulation of the inquiry should lead to a result so different from Dr. Dunlap's wider experience therewith. The most ardent local pride can scarcely ascribe it essentially to differences between "value of life" or intellectual honesty, in Maryland, and Massachusetts or Rhode Island. Moreover, not all the present samplings, at least, are of local origin. Nor is it likely that appeal can be taken to differences of age or I.Q. If the real cause is an unrecorded difference in mode of questioning (*e.g.*, subtle influence of the opening lines in the form here used) the result is strong support to Dunlap's long-standing insistence on accuracy of procedural detail in experimental psychology. The measuring of "attitudes" is no exception.

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[1] Especially Mr. C. R. Atwell, Dr. Leonard Carmichael, Dr. Merrill Moore, Mr. David Shakow.

EARLY GEOGRAPHY IN NORTHERN ILLINOIS

CELEBRATION this year of the centenary of settlement in the Rock River Basin in extreme northern Illinois has brought to the surface memories which, unless recorded, will soon be lost.

Once the Indians were disposed of by the Black-hawk War, the region invited white settlers. Most of the early immigrants planned to take up farm land. The margin between forest and prairie runs roughly east-west through the district, with characteristic open glades in the fringes of the forest and peninsulas and islands of woodland ("groves" in local parlance) jutting up from the prairie. The young men of 1834 and 1835, first on the ground, took up farms along the margins of the woods. There they had logs for buildings, rails for fences, abundant fuel, and springs and streams for quenching the thirst of man and beast. Adjacent, on the unbounded prairie, their stock could graze freely. One of these first comers in after years told his son that when he took up his quarter-section of land, less than half of which was prairie, he took for granted he would always have unlimited, free, open range for all the animals he might own. He and his neighbors planned to carve fields out of the woods. The steel plow with self-scouring metal moldboard was just being perfected, and no one foresaw that within a generation this plow would replace the native prairie with seeded crops. (This district reached its heyday as wheat country during the high prices of Civil War days. Later it turned to corn (maize), and to-day it lies in the transition zone between the Corn Belt and the Dairy Province.)

The grove which this settler and his contemporaries divided among them was typical of the forest margin. About four miles long and one mile wide, its axis was a small stream which headed in a "big spring" and peat bog in the nearby prairie. Its wooded reach began in association with intermittent bluffs of soft limestone and the dissected high ground which they buttressed. Some miles before reaching its forest-fringed master stream it purled once more across a wide lowland of prairie which spread out at the base of low, stony, grass-covered hills. The vegetation of the grove consisted of oaks of at least half a dozen species, with a strong intermixture of hickories and a sprinkling of ash. On the flood-plain of the stream a few walnuts, butternuts, elms, locusts and hawthorns grew. Poplars were common, chiefly on the margins of the grove, which graded from dense to open woods and finally past isolated outposts to unbroken prairie. Not all the outlying trees were poplars; some were oaks, attested by stumps which stood in the fields until toward the end of the nineteenth century. There was no underbrush and the trees branched high, permitting delicate woodland grasses to carpet the ground. Three or four decades after the land was fenced hazel brush had sprung up thickly, in places making dense copse through which a man had trouble in forcing his way; sumac flourished on dry, thin soil; and wild grapes and other undergrowth grew rank on the flood-plain.

Settlers who came in the 1840s, too late to find unoccupied land along the vegetational contact zone, generally preferred the solid forest to the open prairie, but by 1850 men were actively enclosing the grassland, now recognized as more fertile than the land which had borne trees. Each of these prairie settlers purchased or took up a five- or ten-acre tract of woodland in the heart of the forested section, in order to have fence and fuel wood. When these small lots had been cut off, or when improved transportation substituted wire fences for rails and coal for wood as the source of winter heat in prairie homes, these lands were sold for a song to still later immigrants, mainly Irish, many of whom had come in as laborers on the railroads.

Towns grew apace with the countryside. The earliest roads of the district connected navigable waters of the Great Lakes and Mississippi systems or reached out to the lead mines of the Driftless Area. Settlements sprang up along these roads at forks and where they crossed streams which could furnish power for saw- and grist-mills. Rivulets to-day only five or ten feet across were considered adequate power producers wherever their banks favored the construction of earthen or timber dams. It is probable that these streams flowed more copiously in the early days of settlement—before the forests were felled and before the extensive marshes and bogs in depressions of the morainal prairie were drained by tiling. Streams large enough to be dignified by the name "river" were beyond the control of the first settlers.

When railroads came they followed water-level routes so far as possible. Hence they rarely coincided with the stage-coach roads, which took the shortest lines between major objectives except where they skirted wet lands (flood-plains and morainal depressions) or made for natural fords across streams. As population grew and mechanical devices multiplied, the rivers were dammed for power. These two technological changes—railroads and power dams—produced mushroom growth on new sites and destroyed the hopes of many a stage-route village. A rapids in the master stream afforded the most convenient crossing place, the Rock ford, and later made bridging easy. This same rapids created the largest power unit in the area. Roads, railroads and factories have made Rockford the metropolis, a destiny early recognized when to it was allocated the county seat.

The racial pattern of settlement reflects the stages of land occupance as determined by natural vegetation and water resources. The first wave comprised New Englanders, coming either direct or after a sojourn of a few years or decades in New York State or the Connecticut Reserve of Ohio. They, and one community of Scots, took up the groves and most of the contact zone between forest and prairie. The stream of migrants next turned into the forest. This

the Old Americans shared with a community of English families and with Pennsylvania Germans and Germans from the fatherland. Before all the forest land had been taken up, the new steel plow made the prairie available, and families from New England, New York, Pennsylvania and Germany joined forces in the rush to enclose it. Here and there a group of Irish took root on the prairie, but most of them were relegated by their poverty to the rougher forest lands which no one else had wanted. By the time the Irish and the Scandinavians were coming in force, they had to purchase farms from the children of earlier settlers, since little land remained in the hands of the government. Many of them settled in the towns. Before settlement was complete, all these racial threads were being interwoven into a harmonious fabric of Americans. This process still goes on, with Italians and Lithuanians as the chief strands of later origin. Most of them are city dwellers.

While there was abundant land the different groups clustered in tight neighborhoods, each linked to a different place of origin. As soon as clannish feeling diminished with the passing of the first generation, and all the land came to be occupied, the lines between settlements began to fade. Before 1900 the disappearance of stumpage in the forest and the planting of shade trees on the prairie had minimized the striking contrast in aspect of the landscape which had guided settlement. Intermarriage and interlopers were speedily obliterating the social lines which had formerly distinguished neighborhoods. But just as the natural vegetation has left tell-tale traces in the soil, so relicts of the original settlement—denominational churches, varying styles of farmstead architecture, the predominance of surnames belonging to this or that language—indicate to the observing eye something of the origins of settlement on what is now a typical piece of Midwestern America.

DERWENT WHITTLESEY
HARVARD UNIVERSITY
OCTOBER 3, 1934

A NEW OUTLET FOR UNABRIDGED SCIENTIFIC PAPERS

THIRTY years ago it was not uncommon to find scientific papers forty pages long or even longer. Because of the increase in the number of papers submitted, editors nowadays are compelled to impose strict limitations on the length of each. Yet, because of increased specialization, the need for an efficient medium of interchange of detailed information, between workers in the same or related fields, is greater than it was ever before.

Several solutions of this problem have been proposed in the past.[1] They have a drawback in common—they require the concerted action of many scientific bodies, as well as a radical change in the present methods of publishing scientific papers. These features in a plan make it highly improbable that the plan will be adopted in the near future.

I should like to have the opportunity of presenting through the medium of your journal a suggestion for the partial solution of this problem. This suggestion eliminates the difficulty mentioned in the preceding paragraph and allows of experimentation on a small scale.

The proposed procedure is somewhat as follows: Let the investigator write a paper of a length sufficient to make it useful to his fellow workers. Let him mimeograph his work and send copies to twenty-five key libraries of the world. Let him then present a condensed summary for publication. The summary is to contain a complete list of the libraries in which the unabridged paper is to be found.

I wish to emphasize that the present plan introduces no startling or new ideas. It represents a synthesis of several separate old ones. It seems to me that it is practical and that it will make unabridged papers equally as accessible as short papers published in the less widely circulated journals.

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SCIENTIFIC BOOKS

EARTH, RADIO AND THE STARS

Earth, Radio and the Stars. By HARLAN TRUE STETSON, Ph.D. New York, Whittlesey House, McGraw-Hill Book Co., Inc., 1934; pp. xvii + 336; figs. 88; one colored plate.

A PUBLICATION describing and coordinating the intriguing phenomena of astronomy and those of the earth sciences, more familiar but unfortunately the object of less interpretation, has been a desideratum for some time. The wonders of the heavens and the enchantment of the great unknown represented by the distant celestial bodies have long been the subject of discussion both scientific and popular. It is surprising that the even more complex and certainly equally fascinating physical phenomena evidenced by the experiments performed daily by nature in her great laboratory—the earth and its atmosphere—enlist, in general, little interest from layman and scientist alike. In astronomy there has been no lack of interest from its early beginning. But the intimate relations to the

[1] See, for instance, SCIENCE, 56: 197, 1922; 80: 70, 1934; 80: 245, 1934.

problems of life and our whole environment, so essential to human welfare and progress, because of their very familiarity have met with only limited inquiry and certainly have received little support in comparison to that accorded other fields of scientific investigation.

Dr. Stetson has done a service to geophysicists, astronomers and laymen in this attempt to present in popular form what we know of the physics of the earth and how that knowledge fits with, relates to and expands interpretation of observations in the, as yet, inaccessible regions immediately around the earth and in space. His book should enlist the attention of thoughtful readers and give them a new view of and insight into the familiar everyday phenomena occurring around us and unobserved by almost all.

Dr. Stetson's expressed purpose "to bring together recent conspicuous developments in astronomy and its related fields which may suggest a more intimate relationship between man and his cosmic environment, than has perhaps been generally supposed" is thus well justified. For this study of the relations of the earth to the cosmic scheme he suggests the name *cosmecology,* implying the notion of ecology as used in a biological or botanical sense.

It has been little realized until late years how intimate are the relations which exist between astrophysics—the physics of limitless space—and geophysics—the physics of the earth. The task presented is a large one, involving scientific minutiae and technique of astronomy, of geophysics (as represented by meteorology, oceanography, terrestrial magnetism, volcanology, seismology, hydrology, geodesy, geology), of wireless telegraphy and of all their interrelations—some quite patent, others hidden in the hazy boundaries of our finite understanding.

Naturally the heterogeneity of the materials to be presented and digested in a popular style derived from so many diversified and specialized fields constitutes a herculean task. In this the author is to be complimented upon his general success. At times apparent interrelations suggested by various persons and noted in the book are not susceptible of rigorous scientific scrutiny. One might have hoped that an expert like Dr. Stetson would have more frequently made clear-cut distinctions between interrelations based upon generally accepted materials in these fields and ideas of a more or less speculative nature. However, limitations of space and the brevity demanded by the average reader do perhaps condone omission of digressions of this kind.

The chapters describing tides of the ocean and earth, of variations in latitude and longitude, are excellently treated. The subject of the earth's interior is treated from conclusions based on the investigations and progress made by seismic methods. In the fo chapters dealing with the effects of the sun on hum affairs, on the earth's magnetism, on radio recepti and on the ionized regions, our limitations of know edge are perhaps more clearly indicated. Much spa is devoted to the discussion of radio in relation w the moon, solar eclipses, meteors and the stars. It perhaps still open to question whether the publish investigations of the author and his associates ha been sufficiently rigorous to discriminate between t effects of the lunar cycle and the solar cycle, the pro of which requires an extremely detailed statisti study over a longer period of time than yet availabl

Under the chapter on illuminations of the night sk attention is given chiefly to considerations of t aurora and zodiacal light. In discussing the form the results of recent work, particularly by Norwegi investigators, are briefly sketched. In introducing th subject the author states that "Relatively careful ob servations show that in general these strange illum nations center about the Earth's magnetic poles." I is not clear just what "relatively careful observation are referred to, but the statement is not in accordan with generally accepted data. It might better be sai that the line of maximum auroral frequency in th northern hemisphere is roughly symmetrical about th axis of the earth's uniform magnetic field, the nort end of which is approximately in latitude 78° 3 north and longitude 69° 08′ west.

Two of the final chapters of the book deal briefly with cosmic clouds and cosmic rays. The subject-bib liographies arranged according to chapters are wel selected. The indexes for both name and subject show an appreciation of the usefulness of such features t the reader and student.

The publishers have presented Dr. Stetson's text and numerous diagrams in attractive form.

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ASTEROIDAL AND COMETARY ORBITS

The Calculation of the Orbits of Asteroids and Comets. By KENNETH P. WILLIAMS. Principia Press, Inc. Bloomington, Indiana. Pp. vii + 214. $3.25.

THE author's chief purpose in writing this book was to provide the mathematics student with a mathematical exposition of the methods for the computation of preliminary asteroidal and cometary orbits. There can be no doubt that this purpose is well achieved. The general introductory chapters serve to provide him with the basic ideas of what astronomical positions mean, the systems of coordinates used and the corrections to be applied. Very little of the observational side is presented, but that is not necessary in this type of treatment. The introduction of a chapter

interpolation enhances the value of the book considerably, especially for the student who wishes to mpute. The mathematical foundations of the Laace, Gauss and Olber methods are clearly presented, pecially in the case of the last. The historical etches, though brief, add greatly to the interest and lue of the book. These, coupled with the rather mplete bibliography, make the book of considerable lue for reference purposes.

The chief criticisms apply to the treatment of pracal details necessary for the student who wishes ally to learn to compute orbits. The formulas for mputation are in some portions very detailed and others somewhat sketchy. They are, however, degned for machine computation, which is a definite dvance. The omission of plus signs in the numerical xamples is in bad form for the student learning achine computation, but, of course, the instructor ould watch over such details.

One would rather expect Moulton's "Celestial Meanies" to be used as a standard of notation in an nglish text, but one finds ξ, η and ζ representing the rrection cosines when usually they represent geocentric coordinates in orbit theory. Other changes in notation may cause confusion. The failure to identify explicitly the well-known f and g series in the modified Laplacian method may possibly save computation time, but the treatment almost completely masks these most important series. Their omission as definite entities prevents the student from appreciating the tremendous flexibility of the modified Laplacian methods, such as Leuschner's, when applied to the many problems that the orbit computer will meet.

I can find no mention of Bengt Strömgren's modification of Olber's method, though his nomograms for the solution of the geocentric distance are of great value in computation, both by Olber's and Leuschner's methods.

One may say of the book generally that, in spite of certain deficiencies in the practical treatment of orbit computation, it affords the most complete text on the subject available in the English language. This book should stimulate activity in a part of astronomy somewhat neglected at the present time.

FRED L. WHIPPLE

HARVARD OBSERVATORY

QUOTATIONS

A MESSAGE FROM THE PRESIDENT OF THE AMERICAN CHEMICAL SOCIETY

WITH the American Chemical Society entering a ew year, the fifth of the depression, a circumspection f its affairs may well be made. The society is in a trong position. On account of the interest and effiiency of its permanent officers, the editors of the ournals and their staffs, the American Chemical Soiety is in the front as one of the outstanding scientific rganizations of the world. With the cooperation of he members it will always remain so. The society as weathered the last five years without serious imairment of its functions, and there is every indicaion that the next years will present easier sailing.

The high standard of excellence of the society's jourals is accepted by all. The national conventions and ntersectional meetings of the society are a tremendous timulation and inspiration to the members, and at the ame time attract public attention. It is difficult to uggest basic improvements in these two interests of he society. There is still a third function of the organization, the improvement of the professional standng of the chemist, which may very briefly be disussed. That the chemist should be pictured in the minds of the public in the same category as the physician, engineer or lawyer, is the desire of all who understand chemistry. There are at least two viewpoints s to how this may be best accomplished, and only ime will crystallize the policy which the society as a whole should support. Without mentioning all of the various factors which have aided the professional standing of the physician and of the engineer, only the one which is perhaps the most influential need be cited —the necessity of state examinations and registration. Is the chemist, in order to attain a greater professional standing, willing to accept state examinations and registration before he can practice or become a properly qualified chemist in the eyes of many business executives? Although such a plan will effectively assist the chemist in gaining public recognition, nevertheless years would pass before a system satisfactory to the chemist and to the states could be evolved and before this plan might accomplish its purpose.

The alternative is to educate the public gradually in the manner that has been taking place during the past ten or fifteen years. The industries have manufactured more and more products which touch directly the layman and which are advertised to him as the result of chemical investigations. With such products steadily increasing in number and with the numerous interesting press reports of discoveries involving intricate pure and applied chemistry, the professional standing of the chemist with the laity is bound to improve.

The trained chemist is truly in a favored position to-day. The past decade has seen his services first greatly in demand, and has then seen them diminish, until three years ago a current topic of conversation

among university professors was the problem of employment for the newly trained chemists. The picture has changed once again in the last two years. Unemployment has diminished rapidly until the number who are not placed, and whose training qualifies them for a research position, is relatively small. In fact, it does not now appear to be presumptuous to predict the possibility of a shortage of research chemists within a few years. This situation has been created through the recognition by the executives of an ever increasing number of our industrial organizations of the value and necessity of research. More and more chemists are being diverted to executive positions, to sales or legal departments in various organizations. The desirability of a technical training in these fields is not yet fully recognized.

Compare the chemical profession with any other. Is not the outlook for the chemist very encouraging?

—*Roger Adams*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SECOND EXPERIMENTAL METHOD FOR INCREASING AUDITORY ACUITY[1]

In previous publications[2,3] fixation of the round window membrane with a pledget of cotton or with a living tissue graft was shown to increase the intensity of tones transmitted through the cat's ear from 10 to 30 decibels. In all these experiments the Wever and Bray phenomenon was used to measure the strength of action currents set up in the animal's auditory nerve as a result of the specific sound stimulus applied to the ear. It was shown later[4] that measured increases in intralabyrinthine pressure tended to improve the intensity of tones transmitted, though only to a slight degree; the higher frequencies were affected more than the low. Decreased intralabyrinthine pressure resulted in a marked lowering of the intensity of all tones transmitted.

In the present series of experiments an attempt was made to block the cochlear aqueduct. This was done by drilling a hole with a small dental burr over the position of the aqueduct well away from the cochlea itself. The base of this hole was then scorched with a high frequency cautery, hoping thus to occlude the aqueduct. In two experiments the burr actually perforated the wall of the bulla, and, following recovery from anesthesia, these two animals exhibited what was apparently a cerebellar ataxia. In neither case was nystagmus present. Fourteen such operations were performed under strict aseptic technique. Five animals have been tested subsequently at intervals of from two to three weeks following the original operation. In every instance the intensity of spoken voice was greatly increased on the operated side, using the normal ear as control. In addition pure tones of the octaves from 1,000 d.v. to 8,000 d.v. were increased from 10 to 25 decibels over the normal ear.

To demonstrate occlusion of the aqueduct 10 cc of a 30 per cent. NaCl solution was given intravenously. While the usual rapid falling off of intensity was noted on the normal side, much less effect could be observed on the experimental side. Certainly no greater lowering of pressure took place than might be accounted for by absorption of fluid through the capillary beds of the inner ear itself. Without waiting for the histologic evidence of serial sections it seems safe to assume that the aqueduct had been occluded successfully. The intensity measurements of such an experiment follow:

Frequency	180	250	500	1,000	2,000	4,000	8,000
Right ear (Operated)							
Control, before injection NaCl	27	29	19	29	19	24	70
Immediately after injection	33	24	23	40	26	30	66
½ hour after injection	30	25	26	42	30	35	—
Left ear (Normal)							
Control, before injection NaCl	21	23	33	40	40	50	—
Immediately after injection	19	22	34	37	55	58	—
½ hour after injection	20	25	44	.....	.....	.....	—

The figures beneath the different frequencies represent decibels of attenuation necessary to balance the comparison intensity with the intensity of tone transmitted through the cat's ear.

Two possible explanations of the results observed present themselves. In the first place occlusion of the duct may result in a gradual increase of intralabyrinthine pressure with the resultant improvement in the transmission of the higher frequencies. In the second place the cochlear aqueduct may serve in a minor capacity as an additional safety valve for the cochlea. This function of the round window membrane was originally put forward by Hughson and

[1] From the Otological Research Laboratory and the Surgical Hunterian Laboratory, the Johns Hopkins University School of Medicine. Aided by a grant from the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation.

[2] Walter Hughson and S. J. Crowe, *Jour. Amer. Med. Asso.*, 96: 2027–2028, June, 1931.

[3] Walter Hughson and S. J. Crowe, *Ann. Otol., Rhinol. and Laryngol.*, 41: 332, June, 1932.

[4] Walter Hughson, *Am. Jour. Physiol.*, 101: 396–407, July, 1932.

Crowe[5] and more recently additional evidence to support the theory has been reported by Hughson and Witting.[6] True, it would seem unlikely that the cochlear aqueduct was of sufficient size to function in this "safety valve" capacity.

In all but one of the animals tested the bulla and middle ear on the operated side were entirely clear when examined at autopsy. In one case granulations filled both the middle ear and bulla, making the improved transmission of all frequencies even more remarkable.

CONCLUSIONS

(1) Experiments designed to obstruct the cochlear aqueduct in cats have resulted in a marked increase in the intensity of spoken voice and pure tones transmitted by the operated ear.

(2) Without histologic proof of actual occlusion withdrawal of fluid from the labyrinth and the resulting decrease in efficiency of the ear by intravenous injection of a hypertonic NaCl solution has been definitely obviated by the experimental procedure.

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A SIMPLE METHOD FOR MAKING LOW-POWER PHOTOMICROGRAPHS

SEVERAL days ago it became necessary to make a series of low magnification photomicrographs of insect dissections. Believing that other organizations may be in the same financial position as we are and in need of such an apparatus prompts me to describe it. It was made from materials found in the laboratory and cost only a little time.

An ordinary student's microscope is mounted upside down on a vertical iron rod by means of two condenser clamps. Above it is similarly fixed a 300 watt gas-filled electric lamp. A housing that might be used for projection drawing is fashioned of a light wooden frame and beaver board. The measurements of this box are 12″ high by 24″ by 18″ with the bottom and the 24″ front open. A hole cut into the center of the top fits snugly around the microscope tube. As the device now stands it may be used as a small demonstration projector for class work or for making projection drawing.

To convert it into a camera all that is needed is a blanket or a large piece of black oilcloth. We used three regular rubberized laboratory aprons. The operator sits in the position to make a projection drawing and envelops himself and the open side of the housing with the dark cloth. The plates used are Eastman Slow Lantern Slide Positives. The plate holder is an empty lantern slide plate box. The procedure is simple. The slide is focused on a piece of paper as for drawing. The closed lantern slide box containing a plate emulsion side up is moved into place and the light turned off. The cover of the box is then removed and the light again turned on for the duration of the exposure. The cover is then replaced and the slide taken to the dark room for development.

We found that so long as the operator was unable to read the lettering on the box cover the interior of the "camera" was safe for these plates. Satisfactory negatives were made with the following combinations and exposures.

Objective	Ocular	Projection distance	Exposure
16 mm	7.5×	11 inches	20 sec.
Zeiss a_2 3×	7.5×	11 inches	2 sec.

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SPECIAL ARTICLES

SELENITE—A CRITERION OF EFFECTIVE WIND SCOUR

THE future student who explores the intricacies of geomorphic literature will, according to his nature, be amused or exasperated in comparing Lang's note "Selenite Not a Certain Indicator of Wind Effect"[1] with our note published four years earlier[2] entitled "Selenite Fragments or Crystals as Criteria of Wind Action."

We hold that laboratory experiment in sandblasting produces a frosted surface on selenite so quickly that "it is inconceivable that bright selenite fragments could exist in an area having effective action by wind-blown sand." We suggest that selenite surfaces are dulled by solution within a few years in the climates prevailing in most parts of the United States where such fragments are found on the surface. Yet even this is a long time compared to the few minutes necessary for frosting by the sand blast. Therefore the presence of such fragments on the surface may be used as indicative of the general absence of effective wind scour.

[5] See note 2.

[6] Walter Hughson and E. G. Witting, *Acta Oto-Laryngologica* (in press).

[1] Walter B. Lang, SCIENCE, 80: 117–118, August 3, 1934.

[2] Walter H. Schoewe and Kirk Bryan, SCIENCE, 72: 167–170, 1930.

Now Lang cites crystals of selenite thrown out of a railroad cut in 1891 near Salt Draw, twenty miles south of Carlsbad, New Mexico. These crystals have bright cleavage faces due to the "lack of tools sufficient to make wind action effective." It should be noted also that these "bright" cleavage faces have persisted for over forty years. Can it be possible that the masses of selenite have been broken and rebroken by casual passersby?

In this region Lang points out that dust is carried in the air, that sand is blown out of the bed of Pecos River and that soil is lifted from cotton fields. All these phenomena occur, and one of the present writers can confirm the observations by personal experience as the result of field work in this area. However, our statements quoted above make no claim that selenite fragments or crystals are criteria bearing on deflation and wind transportation but merely on corrasion by wind-blown sand, *i.e.*, wind scour. All criteria of geomorphological process must be used with caution and applied to the process to which they pertain.

If we consider the area adjacent to Pecos River near Carlsbad and particularly that south towards Pecos City, Texas, the dominant land forms are pediments and terraces produced by stream action, either of Pecos River or of its tributaries. These features record three gradients of Pecos River, 30, 75 and 150 feet above its grade. The broad and recently abandoned flood-plain is actually a terrace 20 feet above river grade. The two higher terraces are described in print[3] and the lower terrace, only 10 feet above the flood-plain or about 30 feet above river grade, is described in a manuscript report.[4]

The sequence of terraces appears to be the same as that so admirably described by Nye[5] for the Roswell area. The recently abandoned flood-plain of the river is Nye's Lakewood terrace, the 30, 75 and 150 terraces correspond to the Orchard Park, Blackdom and Diamond A surfaces.

In addition to stream erosion, ground water solution of salt, gypsum and limestone beds is very active. There are numerous sinkholes joined by the destruction of intervening rises. The solution of caverns and their collapse is also accompanied by deposition of material in the caverns, as pointed out by Lee.[6]

[3] O. E. Meinzer, B. C. Renick and Kirk Bryan, *U. S. Geol. Survey Water Supply Paper* 580A, p. 6, 1926.

[4] Kirk Bryan, Geology of Avalon Reservoir, Carlsbad Irrigation Project, New Mexico, with respect to proposed increase in height of the dam, Feb., 1927 (Files of the Ground Water Division, U. S. Geological Survey).

[5] A. Y. Fiedler and S. S. Nye, U. S. Geol. Survey, *Water-Supply Paper* 639, pp. 10–14, 1933.

[6] W. T. Lee, U. S. Geol. Survey, *Bull.* 760, pp. 107–121, 1925.

In the area south of Carlsbad, the sinkhole or Karst topography is less developed west of the river than east of it. Nevertheless, near Salt Draw on the west side of the valley close to the locality noted by Lang the generally stream-modeled topography is modified by solution and fill.

East of the river a great mantle of wind-blown sand partly conceals the details of a topography whose major features are dissected pediments modified by sinkholes. The sand has been lifted from the channel of Pecos River and its eastern tributaries by strong westerly and southwesterly winds. This process goes on at present and apparently was characteristic of each of the previous erosional stages. But this movement of sand and its accumulation to form the extensive body shown on Darton's geologic map of New Mexico and referred to by him[7] as the "Mescalero Sands" takes place on the east side of the valley. The existence of these sands and the extensive wind work to which they testify does not, however, indicate wind scour on the west side of the valley. Even within the area of the sands, wind scour is at a minimum, as this area is primarily one of deposition. The more or less continuous rearrangement of the sands by wind leads to wear of sand on sand, not to wear of sand on the underlying bedrock, *i.e.*, true wind scour.

Thus a careful reading of Lang's paper and a consideration of the area to which he refers indicates that he actually uses selenite fragments as criteria for wind scour in the way and to the extent that we indicate, in spite of his somewhat confusing title.

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[7] N. H. Darton, U. S. Geol. Survey, *Bull.* 794, p. 59, 1928.

THE OCCURRENCE AND ACTIVITY OF UREA-SPLITTING BACTERIA IN THE SEA

IT is recognized that microorganisms which ferment urea play an important rôle in the nitrogen cycle and in soil fertility, and they are known to be quite widely distributed in soil, sewage, manure and fresh water. There are fragmentary accounts of the occurrence in the sea of urea-splitting bacteria, but most of the work has been done in bays or near shore. During the past thirty months we have been making observations to ascertain if there are significant numbers of urea-splitting bacteria which are functional in and indigenous to the sea, or if those found in the sea are merely passive terrestrial contaminants.

Numerous samples of water and bottom deposits have been collected at sea from the boat *Scripps* by

ch rigorous sampling technique[1] as to preclude ossibilities of terrestrial contamination. The samles were inoculated into selective media consisting of Mandler filtered sea-water containing 2.0 per cent. rea and 0.2 per cent. each of glycerol, dextrose and lcium lactate. The hydrogen-ion concentration was aintained near pH 8.2 by the addition of magneum carbonate. Following incubation, growth and mmonium formation were used as the criteria of rea fermentation.

The relative abundance of urea-splitting bacteria as estimated by using inocula consisting of different ilutions of the water or mud samples. The majority f the 1.0 cc inocula of water collected near the surace yielded positive results, nearly half of the 0.1 cc nocula did likewise, and the 0.01 cc inocula did so nly infrequently. Obviously, this indicates the presence of from 1 to 10 physiologically active ureaplitting bacteria per cc of sea water. Similar deductive analytical procedures revealed that this is approximately the order of magnitude of the number of urea-splitting bacteria found throughout the euphotic zone to a depth of 50 meters in the Pacific Ocean in the region of Scripps Institution. Occasionally, urea-splitting bacteria are encountered in water 500 meters deep, but, in general, very few are found below depths greater than 100 meters. However, that neither depth nor the accompanying hydrostatic pressure are limiting factors has been shown by the recovery of numerous urea-splitting bacteria at depths exceeding 1,000 meters. Analysis by the dilution method of 16 mud samples collected at depths ranging from 160 to 1,300 meters showed that the surface mud contained from 10 to 1,000 urea-splitting bacteria per gram. From the examination of cores it was found that these bacteria are most abundant in the upper 2 to 3 cm of mud, and decrease progressively with the depth of the cores. Also, urea-splitting bacteria have been demonstrated associated with the integumental slime and intestinal contents of several marine fish.

Twelve pure cultures of urea-splitting bacteria, differing morphologically or physiologically from each other, have been obtained by streaking inocula of the enriched cultures on urea sea-water agar. These have been characterized according to standard methods.[2] Apparently they are new species and will be described elsewhere. Most of these cultures are quite different from the terrestrial urobacteria which have been described.

As further evidence that these urea-splitting bacteria are functional in and indigenous to the sea and probably even foreign to other habitats, it was noted that following primary isolation the majority of them would grow only in sea-water media and not in corresponding media prepared with fresh water. However, by the use of massive inocula, by gradually diluting sea-water media with fresh water, or by prolonged laboratory culture these marine urea-splitting bacteria could be acclimatized to grow in either sea-water or fresh-water media. This is a characteristic which is common to many bacteria isolated from the sea under conditions which preclude chances of contamination and has been discussed previously.[3]

Although the authors are not convinced that bacterial urease is elaborated extracellularly, this enzyme has been demonstrated by the Mandler filtration of 750 cc quantities of substrata which have been acted upon by the bacteria. The optimum temperature for the activity of the urease from one culture was found to be several degrees higher than the optimum temperature for the reproduction of the culture. Also, whereas the activity of the isolated urease was imperceptible after several days' incubation at +5° C., the bacteria from which the urease was extracted multiplied and formed ammonium from urea at −4° C. The explanation of this equivocal observation may be a difference in the quantity of enzyme or it may be the lack of certain co-enzymes in the isolated urease extract which are associated with the intact bacterial cells. Whether or not urea-splitting bacteria are functional at near zero temperatures is especially significant in the sea, inasmuch as over four fifths of the ocean floor is perpetually colder than 3° C. Rubentschik[4] has commented on the activity of *Urobacillus psychrocartericus* at temperatures as low as −2.5° C.

On a basis of their relationship to the substrate three different types of urea-splitting bacteria have been isolated from the sea: (a) Those which grow well in media containing no other source of nitrogen except urea, but liberate no detectable excess of ammonium. We classify these with the urea-splitting bacteria because it is believed that they must cleave the urea molecule before the nitrogen of the latter can supply the metabolic requirements. (b) Those which multiply freely in urea media and produce an excess of ammonium. Some of these produce enough ammonium to make the sea water as alkaline as pH 9.7. These bacteria may play a rôle in the precipitation of calcium carbonate from sea water.[5] (c) Those which do not start to multiply in urea media unless a little ammonium, amino-acid or peptone nitrogen is added to initiate multiplication, after which urea is decom-

[1] C. E. ZoBell and C. B. Feltham, *Bulletin*, Scripps Instit. Oceanog., tech. ser., 3: 279–296, 1934.

[2] Soc. Amer. Bacteriologists, "Pure Culture Study of Bacteria," Geneva, N. Y., 1931.

[3] C. E. ZoBell and C. B. Feltham, Fifth Pac. Sci. Cong., Victoria and Vancouver, *Proc.*, vol. 3, pp. 2097–2100, August, 1934.

[4] L. Rubentschik, *Centralbl. f. Bakt.*, II Abt. 64, pp. 166–174, 1925.

[5] W. Bavendamm, *Archiv. f. Microbiol.*, vol. 3, pp. 205–276, 1932.

posed with the formation of ammonium. We have observed no marine bacteria which require urea for their growth.

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A GROWTH-INHIBITING SUBSTANCE IN LETTUCE SEEDS[1]

LETTUCE seeds which fail to germinate on moist blotters at 25° C. in the light may be germinated at this temperature by placing the seeds on moist absorbent cotton or in water.[2] The increased germination obtained by this method suggests that the promotion of germination may be due to the exit of an inhibiting substance which diffuses from the seed into the aqueous medium. If an inhibiting substance is formed during the process of germination then the repeated placing of seeds in contact with the same substratum should cause a gradual reduction in the percentage of germination. The germination tests that have been made on cotton and in water to test this hypothesis show that lettuce seeds do form a substance of unknown nature which diffuses from the seed, and if present in sufficient quantities prevents germination.

The inhibiting material is formed most readily by freshly harvested seeds of the white-seeded varieties of lettuce which tend to go into dormancy at 25° C. Big Boston lettuce seeds which germinated 3 per cent. on moist blotters at 25° C. in the light germinated 80 per cent. when placed on moist cotton. The percentage of germination upon this same cotton medium was reduced to 5 per cent. after five lots of 100 seeds each had been in contact with the medium over a period of 10 days. In like manner germination in a shallow layer of water was completely inhibited after 600 seeds had been in contact with the medium. When the water from a similar inhibiting medium was used to moisten a freshly prepared cotton substratum the germination of lettuce seeds upon the cotton was reduced from 80 per cent. to 10 per cent. A saturated medium which inhibited the germination of Big Boston seeds at 25° C. failed to prevent the germination of Black Seeded Simpson seeds of the same age, which indicates that the physiological condition of the seed is a factor in determining the response made by seeds to the inhibiting substance.

The increased germination of lettuce seeds in the light indicates that light may promote the diffusion of the substance from the seeds, and although light may accelerate the process, tests have shown that the inhibiting substance passes from the seeds in total darkness. A cotton medium upon which 600 new crop lettuce seeds had been in contact for a period of 10 days in the dark, and then used as a substratum for germination in the light completely inhibited the germination of one-year-old Big Boston seeds. When this cotton medium was washed in water and then used as a substratum a similar lot of seeds germinated 98 per cent.

The age or more specifically the physiological condition of the lettuce seed is a factor influencing the formation of the inhibiting substance, and is also a factor in determining the response made by seeds when placed in contact with a saturated substratum. The inhibiting substance is formed most abundantly by seeds immediately after harvest and in smaller amounts or not at all in old seeds, and appears to be in some way associated with the dormant condition which develops in the seeds when placed at unfavorable temperatures for germination. The marked increase in germination obtained in the light indicates that light may facilitate the passage of the inhibiting material from the seed. The response to light is complicated by the fact that the dormant condition in light-sensitive lettuce seeds can be broken by placing the seeds in an atmosphere that is saturated with water vapor and giving them an exposure to light. The latter response may take place in swollen seeds within a few seconds and without the presence of water in the form of a film surrounding the seed which precludes the possibility of any substance diffusing from the seed. The fact that the material may pass from the seed in total darkness indicates that the function of light is to prevent or break the stable condition of unknown nature which characterizes seeds in secondary dormancy.

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[1] Approved by the director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 53, October 24, 1934.

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